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ABSTRACT

Designed to supplement the Agriscience Education for the Middle School curriculum guide, this instructional packet provides lessons to enable agriscience teachers to bring basic science concepts into the classroom through practical, hands-on activities and experiments. The course is designed to assist seventh-grade students in exploring science as it relates to agriculture. It is divided into eight duty areas: becoming oriented to agriscience exploration, recognizing the importance of agriculture/agriscience, conserving natural resources, exploring research in agriculture, exploring plant science, exploring animal science, introducing basic laboratory skills, and encouraging personal development. An introductory sheet to each duty area lists competencies/tasks, two to nine lessons, and evaluation. Each lesson consists of any or all of these components: student objective; references; equipment, supplies, materials; presentation (introduction, motivation, discussion with questions and answers, other activities, conclusion, and evaluation); evaluation (test) with answer key; and handouts and worksheets. Equipment lists are appended. (YLB)

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Agriscience Education
for the Middle School

ED 407 502

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Instructional Units
Grade 7: Agriscience Exploration

Virginia Department of Education
Office of Vocational, Adult, and Employment Training Services
Richmond, Virginia 23218-2060

1996

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Agriscience Education for the Middle School

Instructional Units

Grade 7:
Agriscience Exploration

Developed by
Virginia Department of Education
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Main Writer for Project
Darla Miller, Graduate Student, Virginia Tech

Selected Duty Area Writers
Kim Black, Agriscience Instructor, R.E. Aylor Middle School
Brad Bryant, Agriscience Instructor, Park View Middle School
Tonja Cupp, Agriscience Instructor, North Fork Middle School
Cathy Hughes, Agriscience Instructor, John C. Meyers Middle School
Jeff Perry, former Agriscience Instructor, Marshall Junior High School

The Agriscience Advisory Council
Kim Black, Agriscience Instructor, R.E. Aylor Middle School
Brad Bryant, Agriscience Instructor, Park View Middle School
John Carpenter, Agriscience Instructor, Carroll County
Tonja Cupp, Agriscience Instructor, North Fork Middle School
Cathy Hughes, Agriscience Instructor, John C. Meyers Middle School
Posey Jones, Agriscience Instructor, Blacksburg Middle School
Jeff Perry, former Agriscience Instructor, Marshall Junior High School
Jon Utin, Science Instructor, Blacksburg Middle School
Sally Weaver, Agriscience Instructor, Beverly Manor Middle

Editor
Dr. J. Dale Oliver, Professor Emeritus of Agricultural Education, Virginia Tech

Project Coordinator
Dr. John Hillison, Professor, Agricultural Education, Virginia Tech

Curriculum Developers
Agricultural Education Service, writers of the curriculum guide

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Final editing, design, and production were performed by the Virginia Vocational Curriculum and Resource Center, administered by the Department of Technical and Continuing Education, Henrico County Public Schools:

Peggy L. Watson, Director
Karen T. Westermann, Writer/Editor

FOREWORD

This instructional packet is designed to supplement the Agriscience Education for the Middle School curriculum guide. Use of these lessons will allow agriscience teachers to bring basic science concepts into the classroom through practical, hands-on activities and experiments.

This instructional packet has been designed for maximum flexibility. Materials included in the packet serve as a foundation for agriscience instruction. The format of these lessons does not imply that the material should be taught in a particular way; the lessons are offered only as resources.

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AGRISCIENCE EDUCATION
GRADE 7: Agriscience Exploration (8003)

- **Agriscience Exploration (8003)**

  This course is designed to assist students in exploring science as it relates to agriculture. Through well-planned instructional activities, students have the opportunity to develop an understanding of human relations, communication, the importance of agriculture to the economy, and key scientific terms related to the field of agriculture. The course is offered on a semester basis for seventh-grade students.

- **Suggested Duty Areas**

  Duty Area 0: Becoming Oriented to Agriscience Exploration
  Duty Area 1: Recognizing the Importance of Agriculture/Agriscience
  Duty Area 2: Conserving Natural Resources
  Duty Area 3: Exploring Research in Agriculture
  Duty Area 4: Exploring Plant Science
  Duty Area 5: Exploring Animal Science
  Duty Area 6: Introducing Basic Laboratory Skills
  Duty Area 7: Encouraging Personal Development

DUTY AREA 0: OVERVIEW
Becoming Oriented to Agriscience Exploration

- **Competencies/Tasks**
  - 0.1 Explore ideas associated with agriculture.
  - 0.2 Identify class rules and procedures.
  - 0.3 Complete student information forms.

- **Lessons**
  - 0.1 Ideas Associated with Agriculture
  - 0.2 Class Rules and Procedures
  - 0.3 Student Information Forms

- **Evaluation**

  Suggestions for evaluation appear at the end of each lesson. A sample quiz appears at the end of the duty area.

DUTY AREA 0
Becoming Oriented to Agriscience Exploration

Lesson 0.1 Ideas Associated with Agriculture

Student Objectives

1. Develop definitions of *agriculture, agriscience,* and *agribusiness.*
2. Explore ideas associated with agriculture.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications*. Albany: Delmar Publishers, Inc., 1990.

Farm and Food Bytes: Introduction to Agriculture. Software. Stratford: Agricultural Education, 1988.

Food from Farm to You. Film. Peoria: Venard Films.

Virginia Agriculture in the Classroom. Richmond: Virginia Farm Bureau Federation.

Equipment, Supplies, Materials

computer
TV/VCR
16 mm movie projector

Presentation

A. Introduction

Agriculture encompasses a wide variety of activities, including areas such as plant and animal production, harvesting and marketing products, and genetic engineering. This lesson presents definitions of the terms *agriculture, agriscience,* and *agribusiness;* explores ideas associated with agriculture; and examines agriculture's relationship with science.

B. Motivation

1. Have students write down all of the products they can think of that originate from plants and animals. Discuss these products and add other products or by-products that were missed.
2. Have students list everything they ate for supper the previous evening and the origin of each of the main ingredients.

C. Discussion

1. *Question: What do the words* agriculture, agriscience, *and* agribusiness *mean?*
   Answer:
   - Agriculture: all the activities related to the production, processing, distribution, and marketing of food and fiber products
   - Agriscience: the application of scientific principles and new technologies to agriculture
   - Agribusiness: the part of agriculture that deals with agricultural production, processing, distribution, and marketing

2. *Question: What are some of Virginia's agricultural products? What raw materials do they require, and where are they produced?*
   Answer:

Product	Raw Materials/Origin	Region
Milk	dairy cows	Ridge and Valley, Piedmont
Bread	wheat, grains	Piedmont
Hamburger	beef cows	Ridge and Valley
French fries	potatoes	Tidewater
Pizza sauce	tomatoes	Tidewater
Blue jeans	cotton	Piedmont
Baby lotion	soybeans	Piedmont and Tidewater

   Virginia Agriculture in the Classroom lists other products as well.
   Suggested Activity: Have students create a poster illustrating various agricultural products and the steps required in processing them.

3. *Question: What are some types of businesses that are related to agriculture?*
   Answer:
   grocery stores
   florists
   hardware stores
   machinery dealers
   lumber yards
   trucking businesses
   Suggested Activity: Have students name other local businesses that are related to agriculture and explain how they are related.

4. Question: *What agricultural products do these businesses handle?*
   Answer:
   - grocery stores: meats, vegetables, dairy products
   - florists: flowers, potted plants
   - hardware stores: gardening equipment, tools, nails
   - machinery dealers: tractors, combines, plows
   - lumber yards: wood, pine bark mulch
   - trucking business: meats, vegetables, lumber, milk

   This list can be used as an introduction to careers related to agriculture. Later lessons address this topic specifically.

5. Question: *What are the four major divisions within agriculture?*
   Answer:
   - Production: producing food and fiber
   - Processing: changing food and fiber into consumer products
   - Distribution: moving products to the market
   - Marketing: selling products

   Have students select an agricultural product and trace its path from the farm to the home. Require students to be specific about the scientific procedures required in processing, e.g., the procedure for pasteurizing milk.

6. *Question: How are agriculture and science related?*
   Answer: Agriculture is the application of the earth, physical, and life sciences. Earth science is the study of soils and sunlight; physical science is the study of simple machines, energy, and matter; life science is the study of plants, animals, and the environment.

D. Other Activities
   Show the film *Food from Farm to You.*

E. Conclusion
   Agriculture encompasses much more than farming. It includes all the procedures required to get food and fiber from the farm to the table. Understood in this way, agriculture affects nearly every aspect of life.

F. Evaluation
   A sample test is provided at the end of the duty area.

Lesson 0.2 Class Rules and Procedures

Student Objective

Identify class rules and procedures.

References

Burke, Stanley R., and T. J. Wakeman. *Modern Agricultural Mechanics*. Danville: Interstate Publishers, Inc., 1992.

Cooper, Elmer L. *Agriscience: Fundamentals and Applications*. Albany: Delmar Publishers, Inc., 1990.

Equipment, Supplies, Materials

copies of school and student handbooks

Presentation

A. Introduction

The first lesson explored some of the ideas associated with agriculture. This lesson covers procedures and rules for the classroom.

B. Motivation

Ask students to explain the necessity of classroom rules and procedures. Explore what would happen if there were no rules or procedures.

C. Discussion

1. *Question: What rules should be established for this class?*

   Answer:

   - Come prepared: bring a pencil and an agricultural notebook to class each day.
   - Be in seats when the tardy bell rings.
   - Do not chew gum or eat food.
   - Raise hand for permission to speak.
   - Be polite and courteous.
   - Show respect for others.
   - Do not sharpen pencils during class.
   - Do not leave the classroom or laboratory area without permission.

   These are some basic rules for a classroom; specific rules may vary based on school division policies. Read each rule, discuss its importance, and make sure each student understands its meaning.

2. *Question: Which classroom procedures will be followed in this class?*

   Answer:

   roll call
   administrative and departmental announcements
   presentation of class or laboratory materials

review of class materials or laboratory cleanup
dismissal by the teacher

The teacher may add additional procedures.

3. *Question: What is the grading policy?*

   Answer: Suggested grading policy:

   Quizzes 10%
   Agricultural notebook 15%
   Tests 35%
   Projects (classroom and lab) 35%
   Homework 5%

   Explain why different percentages are assigned to different activities. If appropriate, let students set the grading scale. If students do not receive letter grades, alter the policy as required.

D. Other Activities

Use Lesson 0.3 to collect student information.

E. Conclusion

Review classroom rules and grading policy.

F. Evaluation

A sample test is provided at the end of this duty area.

Lesson 0.3 Student Information Forms

Student Objective

Complete an information sheet.

Equipment, Supplies, Materials

file folder
index cards
information sheet (7VA 0.1)

Presentation

A. Introduction
People who work together normally have some basic information about each other. Information forms are one way to collect this information.

B. Motivation
Have students list different ways to contact people and how the information needed to do so is found, e.g., telephone books, organization directories, school files, address books. Discuss how the information form might be used.

C. Assignment
1. Have students purchase a file folder and place their name on the file tab, last name first. Place the student information sheet inside the folder.
2. Instruct students to complete the information sheet neatly (6VA 0.1). It may also be helpful for the teacher to read each question on the form aloud.

D. Other Activities
Information about students and their schedules can be placed on index cards and stored in a file box for the teacher to use at home.

E. Conclusion
Explain what will be done with these information sheets. Example: These information sheets will be kept on file in this department.

F. Evaluation
Grade students on their ability to complete the form accurately.

Duty Area 0 Evaluation
Becoming Oriented to Agriscience

Name_____

Date _____

I. True or False: circle the correct letter.

T F 1. The milk we drink comes from a beef cow.
T F 2. Hamburger is a product from a hog.
T F 3. A lumber yard depends upon agriculture.
T F 4. Agriculture can be defined simply as farming.
T F 5. Science and agriculture are closely related.
T F 6. Bread comes from wheat or other small grains.
T F 7. A florist's shop depends upon agriculture.
T F 8. Distribution involves moving agricultural products to the market.
T F 9. The process of producing food is called *production.*
T F 10. Agriscience is the application of scientific principles to agriculture.
T F 11. The Commonwealth of Virginia is divided into four regions.
T F 12. The Piedmont region includes the mountainous part of Virginia.
T F 13. Tomatoes are grown in the Tidewater region.
T F 14. Baby lotion is a product made from wheat.

II. Short Answer: write your answer in the space below the question.

15. Name four local businesses that are associated with or dependent upon agriculture, and list the products they sell.

_____

_____

_____

_____

16. Give three examples of how agriculture and science are related.

_____

_____

_____

17. List the four main divisions of the agriculture industry.

_____

_____

_____

_____

18. Select an agricultural product and explain its path from farm to store.

19. Why is it necessary to have rules in a classroom?

20. List five rules of this classroom.

_____

_____

_____

_____

_____

Becoming Oriented to Agriscience Answer Key

1. F
2. F
3. T
4. F
5. T
6. T
7. T
8. T
9. T
10. T
11. F
12. F
13. T
14. F
15. Answers will vary.
16. Answers will vary.
17. Production, processing, distribution, and marketing
18. Answers will vary.
19. Answers will vary.
20. Answers will vary.

Student Information

Class Period _____

Name _____ Age _____ Sex _____
Last First Middle

Address _____
Rt., Box #, Apt., Street Town State Zip

Phone number _____ Date of Birth _____ Grade in School _____

Social Security Number _____ Bus number _____ Load _____

Name of Parents or Guardians _____

Address of Parents _____
(If different from yours)

Occupation of Parents: Father: _____ Phone: _____
Mother: _____ Phone: _____

Number in family _____ Brothers _____ Sisters _____

Do you live on a farm? _____ If yes, how many acres? _____

What is raised or grown? _____

If you do not live on a farm, do you have access to a farm? _____

Do you have garden space? _____ workshop space? _____

space for an animal? _____ hobbies? _____

Class Schedule

Period	Subject	Teacher	Room
Homeroom			
1			
2			
3			
4			
5			
6			
7			

On the back of this sheet, give directions to your house by drawing a map or listing them step-by-step.

DUTY AREA 1: OVERVIEW
Recognizing the Importance of Agriculture/Agriscience

- **Competencies/Tasks**
  - 1.1 Explain the importance of agriculture to Virginia, the United States, and the world.
  - 1.2 Describe the relationship of agriculture to other segments of society.

- **Lessons**
  - 1.1 The Importance of Agriculture to Virginia, the United States, and the World
  - 1.2 The Relationship of Agriculture to Other Segments of Society

- **Evaluation**

  Suggestions for evaluation appear at the end of each lesson. A sample quiz appears at the end of the duty area.

DUTY AREA 1
Recognizing the Importance of Agriculture/Agriscience

Lesson 1.1 The Importance of Agriculture to Virginia, the United States, and the World

Student Objectives

1. Discuss the impact agriculture has on Virginia.
2. List 10 agricultural products of Virginia.
3. Discuss how Virginia agriculture affects the United States.
4. Discuss the impact agriculture has on the United States.
5. Discuss the impact agriculture has on the world.

References

Agri America: 2003 A.D. Video. St. Petersburg: Modern Talking Picture Service.

Cooper, Elmer L. *Agriscience: Fundamentals and Application*. Albany: Delmar Publishers, Inc., 1990.

Fact Book of U. S. Agriculture. Washington, DC: Office of Public Affairs, USDA, latest edition.

National FFA Organization. *Food for America.* Alexandria: National FFA Organization, latest program.

Virginia Agriculture in the Classroom. Curriculum Guide. Richmond: Virginia Farm Bureau.

Virginia Agricultural Statistics Annual Bulletin. Richmond: Virginia Agricultural Statistics Service, latest edition.

Equipment, Supplies, Materials

poster board
scissors, glue, tape
TV/VCR

Presentation

A. Introduction

Agriculture is one of the largest industries in the United States, employing more than 20 million people annually. Agriculture touches many aspects of daily life, from the food we eat to the clothes we wear. This lesson discusses agriculture's importance to Virginia, the United States, and the world.

B. Motivation
   1. Play the game *Stump the Teacher.* Have students try to name a job or product that cannot be related to agriculture.
   2. Show the video *Agri America: 2003 A.D.*

C. Assignment
   1. Develop a poster or collage showing all the agriculture products grown in Virginia.
   2. Divide students into small groups and have each group prepare a report illustrating agriculture's importance to Virginia, the United States, and the world.

D. Discussion
   1. Question: *How does agriculture affect Virginia?*
      Answer: Agriculture is very important to Virginia's economy. Agriculture in Virginia
      - is highly diversified (250 commodities)
      - is a $20 billion industry
      - comprises 20% of the total economic outlook
      - provides 20% of Virginia's total jobs
      - produces 40% of Virginia's exports.

   2. Question: *What are the top 10 agricultural products in Virginia?*
      Answer:
      cattle and calves
      milk
      broilers
      tobacco
      turkeys
      peanuts
      horticultural specialties
      hogs
      horses
      eggs

      Suggested Activity: Have students research and present information on the importance of Virginia agriculture to the United States.

   3. Question: *Why is agriculture important in the United States?*
      Answer:
      - It provides food, fiber, and other important products.
      - It is the largest industry in the United States.
      - It employs over 20 million people.
      - It produces low-cost food because of its efficiency, allowing Americans to spend less than 15% of their income on food.

   4. Question: *Why is American agriculture important to the world?*
      Answer:
      - It is the largest commercial industry in the world, with assets exceeding 1 trillion dollars.
      - Annually, each American farmer produces enough food to feed approximately 115 people. Thirty percent of the food which an American farmer produces is exported.

- It provides modern technologies and methods for agriculture in other countries.

E. Other Activities
Use activities in the FFA *Food forAmerica* packet.

F. Conclusion
Agriculture is important because it affects nearly every aspect of daily life and is a significant factor in the nation's economy. It is America's largest industry and also plays an important role in producing food for the world. In Virginia, agriculture generates approximately 20% of Virginia's income.

G. Evaluation
Tests or quizzes can be developed from the material in this lesson. Students can also be evaluated on a project in the *Assignment* section.

Lesson 1.2 The Relationship of Agriculture to Other Segments of Society

Student Objectives

1. Discuss the relationship between agriculture and business and industry.
2. List 10 jobs in the local community that are associated with agriculture.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications*. Albany: Delmar Publishers, Inc., 1990.

National FFA Organization. *Food for America*. Alexandria: National FFA Organization, latest program.

Fact Book of U. S. Agriculture. Washington, DC: Office of Public Affairs, USDA, latest edition.

Virginia Agriculture in the Classroom. Curriculum Guide. Richmond: Virginia Farm Bureau.

Virginia Agricultural Statistics Annual Bulletin. Richmond: Virginia Agricultural Statistics Service, latest edition.

Equipment, Supplies, Materials

transparency master (7VA 1.1)
overhead projector

Presentation

A. Introduction
The first lesson discussed the impact of agriculture locally, nationally, and globally. This lesson examines how agriculture cooperates with other parts of society to provide food and fiber.

B. Motivation
Distribute a food sample, such as potato chips, to each person in class. After tasting the sample, discuss all of the parts of society that played a role in making this food available.

C. Assignment
Have students select a product found in the home and indicate all the parts of society that were involved in its production.

D. Discussion
1. Question: *How does agriculture relate to other segments of society?*
Answer: Use 7VA 1.1 as an example of the various segments of society involved in producing and processing a simple food item.

2. Question: *What are 10 types of businesses in the community that are related to or depend upon agriculture?*
   Answer:
   banks
   craft stores
   grocery stores
   florists and greenhouses
   hardware/farm supply stores
   landscapers
   insurance agencies
   realty companies
   seafood markets
   trucking companies

   Ask students to add other businesses to this list.

E. Other Activities
Divide students into groups of five or six. Have each group develop and present a skit illustrating how a particular agricultural product depends upon all parts of society as it moves from the farm to the store.

F. Conclusion
Agriculture is not an isolated industry, and it must work with and depend upon many other parts of a community. In order to get a product to market, the farmer must work with fertilizer dealers, tractor dealers, bankers, supply stores, packing companies, salespeople, and the stores where the product is sold.

G. Evaluation
Students can be evaluated on the basis of the assignment.

Potato Chip Manufacturing

Farmer

- prepares field for planting
- plants seed potatoes
- harvests potato crop

Potato Chip Manufacturer

- buys potatoes
- washes and destones potatoes
- peels potatoes
- slices potatoes thinly
- washes slices to remove starches
- cooks slices in hot vegetable oil
- seasons and flavors slices
- packages slices

Distributor

- buys packages of chips
- places packages in stores

DUTY AREA 2: OVERVIEW
Conserving Natural Resources

- **Competencies/Tasks**
  - 2.1 Identify kinds of soil erosion.
  - 2.2 Explain factors affecting soil erosion.
  - 2.3 Explain the importance of conserving soils.
  - 2.4 Discuss soil erosion control measures.
  - 2.5 Explain soil and water conservation measures.
  - 2.6 Review agricultural policies concerning air quality.
  - 2.7 Give examples of how the air pollution control program works.
  - 2.8 Explain the relationship between trees and wildlife.
  - 2.9 Identify careers in soil and water conservation.

- **Lessons**
  - 2.1/2.2 Types of Soil Erosion and Factors Affecting It
  - 2.3 The Importance of Conserving Soils
  - 2.4 Soil Erosion Control Measures
  - 2.5 Water Conservation Measures
  - 2.6 Agricultural Policies on Air Quality
  - 2.7 The Air Pollution Control Program
  - 2.8 The Relationship Between Trees and Wildlife
  - 2.9 Careers in Soil and Water Conservation

- **Evaluation**

  Suggestions for evaluation appear at the end of each lesson.

DUTY AREA 2
Conserving Natural Resources

Lessons 2.1/2.2 Types of Soil Erosion and Factors Affecting It

Student Objectives

1. Define the terms *soil* and *soil erosion*.
2. Discuss the factors affecting soil erosion.
3. List the four main types of soil erosion.

References

Camp, William G., and Thomas B. Daugherty. *Managing Our Natural Resources*. Albany: Delmar Publishers, Inc., 1990.

The Water Erosion Process. Slide set. Columbus: Ohio Agricultural Education Curriculum Materials Service.

Virginia 4-H Food and Fiber Systems Curriculum. Virginia Cooperative Extension Service, 1992.

Equipment, Supplies, Materials

slide projector
cassette player

Presentation

A. Introduction

Soil is a renewable resource, but it takes 200 to 400 years for 1 centimeter of topsoil to form. Worldwide, topsoil is being lost at up to 10 times the rate of new soil formation. Soil erosion is a natural process, but can be accelerated as a result of human actions. This lesson examines types of soil erosion and the factors affecting it.

B. Motivation

1. Show the slide set *The Water Erosion Process*.
2. Set up a demonstration to compare the amount of soil run-off between soil covered by sod and soil left bare. Discuss the reasons for the results.

C. Assignment

Before introducing the lesson, have students define the words *soil* and *soil erosion*.

D. Discussion

1. *Question: What is* soil?
   Answer: *Soil* is the thin layer of the earth's crust in which plants grow. Topsoil is the uppermost part of the soil layer and is composed mainly of organic matter.

2. *Question: What is* soil erosion?
   Answer: *Soil erosion* is the removal of soil by water or wind.

3. *Question: What causes soil erosion?*
   Answer:
   water splash, runoff
   wind drying and blowing soil
   accelerated erosion caused by farming, construction
   Suggested Activity: Use pictures or give local examples of these types of erosion.

4. *Question: What are the types of erosion and their causes?*
   Answer: The four main types of erosion are
   - Sheet erosion: the gradual and fairly uniform removal of surface soil; sheet erosion is caused by splash erosion and slow runoff.
   - Rill erosion: small streamlets that are cut into the soil surface by running water; rill erosion is caused by runoff.
   - Gully erosion: rills that have become extremely large; gully erosion is caused by uncontrolled runoff for an extended period of time.
   - Sandblows: the result of wind picking up soil particles and carrying them away; sandblows are caused by the removal of vegetative cover, which allows the soil to become dry and loose.

E. Other Activities

1. Develop a bulletin board on the theme "Soil Erosion in the Community."
2. Have students conduct a survey on soil loss in their locality.

F. Conclusion

Although soil erosion is a natural process, this process can be accelerated by other factors, such as removal of ground covering. Subsequent lessons suggest ways to decrease erosion.

G. Evaluation

Quizzes can be developed from material in the lesson.

Lesson 2.3 The Importance of Conserving Soils

Student Objectives

1. Define the term *conservation*.
2. Identify primary reasons for conserving soils.
3. Discuss major governmental regulations implemented to promote soil conservation.

References

Camp, William G., and Thomas B. Daugherty. *Managing Our Natural Resources*. Albany: Delmar Publishers, Inc., 1990.

Cooper, Elmer. *Agriscience: Fundamentals and Applications*. Albany: Delmar Publishers, Inc., 1991.

Erosion and Weathering. Video. Burlington: Carolina Biological Supply Company.

Lee, Jasper L., and Diana L. Turner. *Introduction to World Agriscience and Technology*. Danville: Interstate Publishers, Inc., 1994.

Troeh, Frederick R., J. Arthur Hobbs, and Roy L. Donahue. *Soil and Water Conservation*. 2nd ed. Englewood Cliffs: Prentice Hall, Inc., 1991.

The Water Cycle and Erosion. Video. Burlington: Carolina Biological Supply Company.

Equipment, Supplies, Materials

TV/ VCR

Agriscience: Fundamentals and Applications (copies for each student in class)

Presentation

A. Introduction

A single centimeter of soil takes hundreds of years to form. However, a single heavy rainstorm on plowed land can wash away more soil than can be formed in 20 years. This lesson presents various conservation practices that can reduce the amount of soil loss.

B. Motivation

Show *Erosion and Weathering* and/or *The Water Cycle and Erosion* and use these videos to discuss the importance of conservation.

C. Assignment

Construct a project illustrating the effect of various types of ground cover on the rate of soil erosion.

D. Supervised Study

Read the section "Land Erosion and Soil Conservation" (pp. 101-103) in Cooper's *Agriscience: Fundamentals and Applications*.

E. Discussion:

1. *Question: What is* conservation?
   Answer: *Conservation* is the wise use of natural resources so they will not be used up or used in ways that harm the environment.

2. *Question:* Why is soil conservation important?
   Answer: When soil is washed away, the nutrients necessary for plant growth that it contains are also lost. Soil conservation practices reduce the amount of soil removed from each year.

3. *Question:* What are some reasons for conserving soils?
   Answer: Some reasons to conserve soil are
   - to protect and keep streams, rivers, and lakes clean
   - to reduce the erosion of topsoil
   - to prevent a reduction in food and crops
   - to reduce air pollution
   - to prevent damage to wildlife
   - to reduce food costs.

   Ask students to suggest other reasons as well. Discuss the importance of each reason suggested.

F. Other Activities

1. Sponsor a contest for posters on the theme of "The Importance of Conservation."
2. In the summer of 1993, a weather system stalled over the Midwest, causing the Mississippi river to overflow its banks by nearly 10 miles in some places. The parts of Iowa, Missouri, and Illinois that border the Mississippi were covered with water for weeks. A large amount of topsoil was washed away, and crops were ruined. Have students pretend they have developed a time machine that allows them to go back in time and decrease the damage caused by this flood. Have students work in groups to develop a plan for saving the soil.

G. Conclusion

Soil erosion will always occur naturally. However, the amount of erosion can be controlled. Conservation practices can ensure that the soil available now will also be available in the future.

H. Evaluation

Evaluate students on their soil erosion projects. Peer evaluation could be used to evaluate the group plans for preventing soil loss.

Lesson 2.4 Soil Erosion Control Measures

Student Objectives

1. Identify basic practices of soil conservation on the farm.
2. Identify practices of non-farm soil conservation methods.

References

Camp, William G., and Thomas B. Daugherty. *Managing Our Natural Resources*. Albany: Delmar Publishers, Inc., 1990.

Cooper, Elmer L. *Agricultural Mechanics: Fundamentals and Applications*. 2nd ed. Albany: Delmar Publishers, Inc., 1987.

Krebs, Alfred H., and Michael E. Newman. *Agriscience in Our Lives*. 6th ed. Danville: Interstate Publishers, Inc., 1994.

Lee, Jasper L., and Diana L. Turner. *Introduction to World Agriscience and Technology*. Danville: Interstate Publishers, Inc., 1994.

Troeh, Frederick R., J. Arthur Hobbs, and Roy L. Donahue. *Soil and Water Conservation*. 2nd ed. Englewood Cliffs: Prentice Hall, Inc., 1991.

Equipment, Supplies, Materials

shallow baking pans (one for each group of students)
potting soil
sprinkling can

Presentation

A. Introduction

Soil erosion can be disastrous for agriculture and the environment, but conservation methods can reduce soil loss. This lesson discusses various practices to prevent soil erosion.

B. Motivation

Divide the class into small groups and conduct an experiment on soil erosion.

1. Divide the class into groups and provide each group with a shallow pan (about the size of a cookie tray), potting soil, and a sprinkler can.
2. Have each group construct a field with a hill at one end.
3. Instruct each group to plow the field with their fingers, using different plowing methods: e.g., one group should plow the hill from top to bottom; one group should plow around the hill; one group should plow from top to bottom and place mulch in the middle rows; one group should plow around the hill and place mulch in a 1-inch-wide strip every three rows.
4. Have students predict which plot will allow water to reach the bottom fastest. Discuss the reasons for their predictions.

5. Elevate the hill end and sprinkle with water. Time the experiment to see which field allows the water to get to the bottom first. Measure soil loss.
6. Summarize the results and discuss which factors affected the water flow.

C. Assignment
Have each student construct a model to illustrate one method for preventing soil erosion.

D. Discussion
1. *Question: Which land areas require constant attention to prevent soil erosion?*
Answer: Some areas that require constant attention are farm land, homes, and construction sites. Discuss how erosion occurs in each of these areas.

2. *Question: Which methods of soil conservation are used on the farm?*
Answer:
   - keeping the soil covered with plants
   - covering bare ground with mulch
   - using planting methods that reduce plowing of the soil
   - using contour practices
   - alternating crops on hilly slopes
   - rotating crops
   - increasing organic matter in the soil
   - using correct amounts of fertilizer to enhance crop growth and root system development
   - developing grass waterways in low areas of the field
   - developing terraces on steep areas
   - avoiding animal overgrazing
   - working with local conservation organizations to develop a soil conservation plan for the farm

3. *Question: Which methods of soil conservation are used around homes?*
Answer:
   - establishing a lawn if area is available
   - mulching gardens and other bare ground areas
   - using ground cover such as shrubs, vines, or other plants on banks and slopes

4. *Question: Which methods of soil conservation are used in construction areas?*
Answer: Construction areas can include areas around a home, business, or highway. As more and more land is used for buildings and highways, there is less exposed ground for water to seep into. As a result, water runoff is more common, and there is an increase in soil erosion. Runoff can be reduced by
   - building diversion ditches
   - constructing waterways
   - channeling runoff water to a sediment basin
   - using vegetative controls such as mulch, sodding, ground covers, and cover crops.

E. Other Activities
Take a tour around the school grounds or community and identify areas of erosion. Develop a plan to reduce or control the problem and implement the plan if possible.

F. Conclusion

The main causes of erosion are wind, water, and humans. Awareness and preventive action is important because soil erosion can go unrecognized until it is quite advanced, and by then it is too late to recover the soil already lost. Being aware of potential problem areas and using conservation methods can help prevent loss.

G. Evaluation

The model developed in the *Assignment* section can be used for evaluation.

Lesson 2.5 Water Conservation Methods

Student Objectives

1. Identify sources of water.
2. Identify a model watershed.
3. Discuss or illustrate a model watershed.
4. Identify water conservation methods.

References

Be Water Wise. Blacksburg: Virginia Water Resources Center, 1988.

Camp, William G., and Thomas B. Daugherty. *Managing Our Natural Resources*. Albany: Delmar Publishers, Inc., 1990.

Cooper, Elmer L. *Agriscience: Fundamentals and Applications*. Albany: Delmar Publishers, Inc., 1990.

Firehock, Karen. *Hands On Save Our Streams: The Save Our Streams Teacher's Manual*. Arlington: Izaak Walton League of America, 1992.

Lee, Jasper L., and Diana L. Turner. *Introduction to World Agriscience and Technology*. Danville: Interstate Publishers, Inc., 1994.

Water in the World. Blacksburg: Virginia Water Resources Center.

Equipment, Supplies, Materials

5-gallon bucket
measuring cups: 2 1-cup measures, 1 1/2-cup measure
a dropper or pipet

Presentation

A. Introduction

Water is the most important resource for human life. The supply of water is inexhaustible, but if it is polluted, it is no longer usable. This lesson examines ways to preserve and conserve water.

B. Motivation

1. Have students list everything that would change if they were without water for a day, a week, and a month. (Note: most purchased food is processed with water, which can be demonstrated by checking labels.)
2. Use *Water in the World* to demonstrate the availability of water for human use.
3. Collect water samples from around the area. Using a water-testing kit and a total dissolved solids meter, have students identify the source of the water based on its color, cloudiness, suspended solids, and conductivity.

C. Assignment
1. Develop a plan for the home, school, or community to reduce water use and to maintain the supply of clean water.
2. Construct a model of the community's watershed. Make suggestions for improvement to reduce pollution.

D. Discussion
1. *Question: What are some sources of water?*
Answer: The four main sources of water are
   - water vapor
   - precipitation
   - surface water
   - groundwater.

2. *Question: What are the sources for most of our water?*
Answer: Surface water and groundwater are the most common sources of water. Surface water comes from rivers, streams, lakes, reservoirs, and other freshwater bodies. Groundwater is water located in the ground: it is found in the cracks and pore spaces of rocks and sediments.
Suggested Activity: To show how groundwater is found in the soil, let a sponge absorb water. Demonstrate that the sponge holds water until it is squeezed, at which point the water is released. Compare this to the action of a well pump.

3. *Question: What are two ways to get to groundwater?*
Answer: The two most common ways of obtaining groundwater are wells or springs.

4. *Question: What is a watershed?*
Answer: A watershed is an area of land where the water runs off into streams and rivers. A watershed can be a small area near a home, or a large area, such as that around the Chesapeake Bay.
Suggested Activity: Identify watersheds in the community. Discuss features of the land that contribute to the layout of the watershed.

5. *Question: What are some causes of pollution in our water sources?*
Answer: Water pollution is caused by non-point and point sources.
   - Non-point sources: sediment, pesticides, animal wastes, and other material that is carried away by water or that seeps into the ground
   - Point sources: pollution caused by using a drain pipe to dump waste directly into a stream; point source pollution is usually caused by factories.

Discuss examples of point and non-point pollution sources in the community.

6. *Question: What are ways to conserve water?*
Answer: Conserving water involves preventing pollution and using water wisely.
   - Using water wisely: limit showers to 5 minutes; don't let water run while brushing teeth; fill bathtub only about 1/4 full; repair leaky faucets and toilets; reuse water to water plants.
   - Preventing pollution: store gasoline and heating oil in above-ground tanks; do not pour oil, paint thinner, pesticides, or other chemicals

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down drains, in toilets, or on the ground; do not store harmful chemicals near wells; prevent farm animal waste from washing into water supplies.

Ask students to add other suggestions to this list.

E. Other Activities
   1. Using a county and state map, trace the flow of a stream or river. Identify features of the watershed that might result in pollution of the water.
   2. Have students investigate water usage around their home.

F. Conclusion
   Water is a precious resource. It must be used wisely and kept free from pollution.

G. Evaluation
   Students may be evaluated on activities in the *Assignment* or *Other Activities* sections.

Lesson 2.6 Agricultural Policies on Air Quality

Student Objectives

1. Define air and its composition.
2. Define air pollution.
3. Identify pollutants affecting air quality.
4. Identify agencies that regulate policies on air quality.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications*. Albany: Delmar Publishers, Inc., 1990.

Va. Department of Air Pollution Control. *Air Quality Regulatory Program for Permitting in Virginia*. Pamphlet. Richmond.

Krebs, Alfred H., and Michael E. Newman. *Agriscience In Our Lives*. 6th ed. Danville: Interstate Publishers, Inc., 1994.

Lytle, R. A., and Harry B. Kircher. *Investigations in Conservation of Natural Resources*. Danville: Interstate Publishers, Inc., 1993.

U.S. Department of Agriculture. *Agriculture and the Environment: The 1991 Yearbook of Agriculture*. Washington, DC: U.S. Government Printing Office, 1991.

Equipment, Supplies, Materials

air pollution test kit
plastic sample containers (e.g., film canisters, floral water tubes)
samples of rain water collected by students at home
distilled water (enough to show neutral pH)
pH paper (for each student) and color chart to show acidity or alkalinity

Presentation

A. Introduction

In the 1970's air pollution became a major environmental concern, and several laws have since been passed to decrease air pollution. This lesson discusses types of pollutants, their causes, and the groups and laws that help maintain air quality.

B. Motivation

Conduct an experiment on water pH.

1. Some time ahead, provide each student with a plastic container to collect rain water in.
2. On the day of the experiment, show students what the pH of distilled water looks like.
3. Have students test their own samples for pH level.
4. Record the results on a chart for the class to see. If certain water samples show high pHs, talk about what the community is like where the sample was collected. Discuss the effects of high acidity levels.

C. Assignment
Have each student prepare a project to illustrate air quality's effects on the planet, e.g., prepare a chart or display, conduct an experiment, perform a skit. Provide an opportunity for students to participate in a science fair at the local, district, area, or state level.

D. Supervised Study
Assign students to read pages 87-91 in *Agriscience: Fundamentals and Applications.*

E. Discussion

1. *Question: What is* air?
   Answer: Air is a colorless, odorless, and tasteless mixture of gases.

2. *Question: What gases combine to make air?*
   Answer: Air consists mainly of the following:

Nitrogen	78%
Oxygen	21%
Argon	0.94%
Carbon Dioxide	0.03%
Water	0.01-4%

3. *Question: What are some of the major air pollutants?*
   Answer:
   sulfur
   hydrocarbons
   nitrous oxides
   carbon monoxide
   chlorofluorocarbons
   pesticide sprays

4. *Question: What causes these pollutants and how can they be reduced?*
   Answer:
   Sulfur and other oxides: A primary source of sulfur is smoke or exhaust from homes, factories, cars, trucks, and tractors. Sulphur and other oxides mix with water vapor to form acid rain. Sulfur dioxide, a by-product, can damage plants and crops. Agriculture has developed power equipment that burns fuels more efficiently to reduce the amount of sulfur emitted into the air.
   Hydrocarbons and nitrous oxides: A primary source of hydrocarbons is the exhaust fumes of motor vehicles. The federal government passed two laws intended to reduce the amount of hydrocarbons emitted into the air: 1) automobiles must be equipped with a catalytic converter, which converts nitrous oxides into harmless gases; and 2) the 1990 Clean Air Act Amendments, which pushed for the elimination of leaded gasoline.
   Carbon monoxide: Most carbon monoxide is emitted in automobile exhaust. Because carbon monoxide is colorless and odorless, it is very hard to remove from air. To reduce carbon monoxide, vehicles should be properly tuned and in good repair, and should not be allowed to idle longer than necessary.
   Chlorofluorocarbons (CFCs): The most common sources of CFCs are aerosol spray cans and refrigeration gases found in refrigerators and air conditioning systems.

CFCs destroy the ozone layer. Industry has stopped producing aerosol cans with CFCs.

Pesticide sprays: Pesticides have been used in agriculture to help control pests. When these chemicals are sprayed on plants, animals, soil, or water, a small amount escapes into the air. Over time, toxins build up and can injure or kill living organisms that are beneficial to society. To help reduce the use of pesticide sprays, agriculturalists have begun using integrated pest management to get rid of harmful pests. This means pests are used to get rid of other pests.

5. *Question: What agencies and laws govern air quality?*
   Answer:
   - The Environmental Protection Agency (EPA) sets the limits on the amount of pollutants that can be emitted into the air.
   - The Clean Air Act of 1970 and its Amendments in 1977 and 1990 provided laws to reduce air pollution.
   - The Department of Air Pollution Control in Virginia governs Virginia's air quality control program and helps enforce policies set up by the EPA and the Clean Water Act.
   - The Farm Bills of 1985 and 1990 address various air quality measures.

   Suggested Activity: Have students gather information on the EPA, the Clean Water Act and Amendments, or the Farm Bills.

F. Other Activities
   1. Have students complete the worksheet on pages 88-89 of *Investigations in Conservation of Natural Resources.*
   2. Use a test kit to measure air quality around the home, school, or community.

G. Conclusion
   Air pollution has become a major problem in the United States, and the agriculture industry must help to maintain air quality. The next lesson presents new technology and methods being developed in the agriculture industry to prevent or reduce air pollution.

H. Evaluation
   Evaluate students on the project suggested in the *Assignment* section.

Lesson 2.7 The Air Pollution Control Program

Student Objectives

1. Explain why air quality is important.
2. Discuss new technologies in agriculture that help to control or reduce air pollution.
3. List ways an individual can keep the air clean.

References

Burton, L. DeVere. *Agriscience and Technology.* Albany: Delmar Publishers, Inc., 1992.

Kircher, Harry B., Donald L. Wallace, and Dorothy J. Gore. *Our Natural Resources and Their Conservation.* 7th ed. Danville: Interstate Publishers, Inc., 1992.

Krebs, Alfred H., and Michael E. Newman. *Agriscience in Our Lives.* 6th ed. Danville, IL: Interstate Publishers, Inc., 1994.

U.S. Department of Agriculture. *Agriculture and the Environment: The 1991 Yearbook of Agriculture.* Washington, DC: U.S. Government Printing Office, 1991.

Equipment, Supplies, Materials

newspapers, magazines, or other sources of articles on air pollution
materials for setting up a science fair display

Presentation

A. Introduction

The last lesson presented issues concerning air pollution and governmental regulations to improve air quality. This lesson considers the importance of clean air and the ways in which agriculture is working to improve air quality.

B. Motivation

1. Invite a speaker from the extension service, air quality board, EPA, or other agency to present a program on air quality.
2. Have students search newspapers, magazines, and other sources of information for current events relating to air pollution. Have students summarize their findings for the class.

C. Assignment

1. Conduct an experiment on acid rain's effects on plant growth, deterioration of materials or other topics related to air quality.
2. Develop an educational exhibit on the development of cleaner burning fuels using agricultural products as substitutes for conventional fuels.

D. Discussion

1. *Question: What are the benefits of clean air?*

Answer:

better health
increased growth of vegetation and higher crop yields
healthier livestock and wildlife
less deterioration of materials
increased visibility

Discuss how each of these benefits result from clean air.

2. *Question: What agricultural developments are helping to reduce air pollutants?*

Answer: Several agricultural projects are being developed to help improve air quality. Some of these are

- using corn to produce ethanol, a fuel additive
- using vegetable oils to produce diesel fuel
- developing technology to convert methane gases into usable energy
- using biomass products (trees, seeds, fruits, food processing residues, and animal manure) as sources of clean-burning energy.

3. *Question: What are some things individuals can do to keep the air cleaner?*

Answer:

- Walk, ride a bicycle, or car pool.
- Keep cars, tractors, and trucks tuned.
- Compost lawn and garden debris.
- Use alternative sources of power, e.g., solar power.
- Avoid or reduce use of chemical sprays.
- Use environmentally safe products.
- Plant a tree.
- Avoid burning plastic bags and styrofoam.

Ask students to add other suggestions to this list.

E. Other Activities

1. Identify a source of air pollution in the community. Have students develop solutions to solve or reduce the problem, and implement these solutions if possible.
2. Participate in Earth Day activities.
3. Plant trees, shrubs, and other vegetation around school grounds.
4. Invite a representative from the Department of Air Pollution Control to speak to the class.
5. Participate in a school, county, district, state, or national science fair competition.

F. Conclusion

Agriculture is taking an active role in keeping the air clean and healthy. Individuals can take an active role as well. Composting, riding bicycles rather than driving, and planting trees are just a few of the ways individuals can help maintain air quality.

G. Evaluation

Quizzes can be developed from the material in the *Discussion* section. Students can also be evaluated on the projects suggested in the *Assignment* section.

Lesson 2.8 The Relationship Between Trees and Wildlife

Student Objectives

1. Identify the types of wildlife found in each of the three major forest biomes.
2. Explain the relationship between wildlife and forests.
3. Identify approved practices in wildlife management.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications.* Albany: Delmar Publishers, Inc., 1990.

Camp, William G., and Thomas B. Daugherty. *Managing Our Natural Resources.* Albany: Delmar Publishers, Inc., 1990.

Understanding Wildlife Management. Video. New York: Instructional Materials Service. Available from Ohio Curriculum Materials Service.

Wright, Jill, Charles R. Coble, Jean Hopkins, Susan Johnson, and David LaHart. *Life Sciences.* Englewood Cliffs: Prentice Hall, Inc., 1988.

Equipment, Supplies, Materials

TV/VCR

Presentation

A. Introduction

The first settlers in America found an abundance of wildlife, forests and other natural resources. Over time, however, more and more woodlands were cut down, decreasing the area available for wildlife. This lesson examines the relationship between wildlife and woodland areas.

B. Motivation (select one)

1. Invite a forest or game warden to present a program on wildlife preservation.
2. Take a nature walk through a local woodlot, wildlife management area, or other wooded area. Have students identify the wildlife they observe.
3. Show the video *Understanding Wildlife Management.*

C. Assignment

Construct a model of a forest biome, including the wildlife that would be found there.

D. Discussion

1. *Question: What factors determine the type and amount of wildlife present in woodlands?*

Answer:

type and age of trees
density of the trees
natural forests openings
types of vegetation found in the forests
natural predators found in the forest

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2. *Question: What does wildlife require for survival?*
   Answer: Water, food, and covering. Forests provide both food and covering for wildlife.

3. *Question: What practices can help maintain wildlife and forests?*
   Answer:
   - Creating clearings so that new growth will become available for animals to feed on.
   - Leaving piles of brush for food and cover.
   - Preventing contamination of water supplies.
   - Preventing forests fires.
   - Using pesticides carefully.

4. *Question: What can be done to conserve wildlife in our forests?*
   Answer:
   - Develop and enforce hunting regulations.
   - Prevent killing of animals on endangered lists.
   - Control the natural enemies of wildlife.
   - Start refuges and sanctuaries.
   - Restock areas where wildlife has disappeared.

E. Other Activities
   1. Develop a forest management plan for a wooded area in the community.
   2. Ask students to select a particular forest animal and imagine it is extinct. Trace how the ecosystem would be affected by its extinction.
   3. Ask students to select an animal previously found in American forests that is now extinct. Have students prepare a presentation on how the animal became extinct and the effects of its disappearance.

F. Conclusion
   Forest wildlife requires a habitat that will provide the essentials of survival. If their habitat is destroyed by human construction and expansion, wildlife cannot survive. Care must be taken to prevent any further extinction of species. Forest conservation plans can help maintain a balance between human development and the needs of wildlife.

G. Evaluation
   Evaluate the model of the forest biome suggested in the *Assignment* section.

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Lesson 2.9 Careers in Soil and Water Conservation

Student Objectives

1. Identify careers in soil and water conservation.
2. Discuss duties and responsibilities related to these careers.
3. List the training needed for these careers.

References

Burton, L. DeVere. *Agriscience and Technology.* Albany: Delmar Publishers, Inc., 1992.

Camp, William G., and Thomas B. Daugherty. *Managing Our Natural Resources.* Albany: Delmar Publishers, Inc., 1991.

Cooper, Elmer L. *Agriscience: Fundamentals and Applications.* Albany: Delmar Publishers, Inc., 1990.

Krebs, Alfred H., and Michael E. Newman. *Agriscience in Our Lives.* 6th ed. Danville: Interstate Publishers, Inc., 1994.

Presentation

A. Introduction

Soil and water are essential to human and animal life. People working in the field of soil and water conservation have an important job in protecting and managing these natural resources. This lesson covers career opportunities in the area of soil and water conservation.

B. Motivation

Invite several people in the field of soil and water conservation to come and talk about their careers.

C. Discussion

1. *Question: What are some careers in soil conservation?*
   Answer: Soil conservationist, range manager, soil conservation technician, soil scientist, soil engineer.

2. *Question: What are some of the duties and responsibilities of people in these careers?*
   Answer:
   Soil conservationists provide assistance to people concerned with conservation; develop farm plans that use the land to its maximum abilities without damaging it.
   Range managers perform the same duties as a conservationist except specialize in grasslands; work with wildlife management; provide advice and technical assistance for governmental land-use planning.
   Soil conservation technicians assist farmers, landowners, etc., in installing conservation practices.
   Soil scientists map and classify soils; identify soil problems (e.g., wetness, erosion); provide technical information for conservationists

Soil engineers analyze and evaluate soils for construction, ponds, and lake sites; evaluate drainage problems; evaluate ability of soil to support structures.

3. *Question: What type of training is needed for a career in soil conservation?*
   Answer:
   Soil conservationist: bachelor's degree; some communication experience
   Range manager: bachelor's degree; some communication experience
   Soil conservation technician: high school diploma
   Soil scientist: bachelor's degree (minimum); strong chemistry background
   Soil engineer: bachelor's degree in some field of engineering

4. *Question: What are some careers in water conservation?*
   Answer: Groundwater geologist, hydrologist, wastewater treatment plant operator

5. *Question: What are some of the duties and responsibilities of people in these careers?*
   Answer:
   Groundwater geologists study the structure, composition, and history of the earth's surface; search for minerals and water; study the movement and reserves of underground water; work closely with hydrologists in seeking new water resources.
   Hydrologists study rainfall, rate of water filtration into the soil, and its rate of return to the ocean; may work with water supplies, irrigation, flood control and erosion.
   Wastewater treatment plant operators control the water treatment equipment that purifies and clarifies water.

6. *Question: What type of training is needed for a career in water conservation?*
   Answer:
   Geologist: bachelor's degree
   Hydrologist: bachelor's degree with an emphasis in science
   Wastewater treatment: high school diploma

F. Other Activities
   1. Have students shadow a person in one of these career areas for a day.
   2. Organize a career fair and invite individuals from all areas of natural resource conservation.
   3. Have students write job descriptions for career areas in natural resources.

G. Conclusion
   Those who work in soil and water conservation play an important role in maintaining natural resources. Individuals who enjoy the outdoors and are interested in protecting the environment may wish to consider a career in soil or water conservation.

H. Evaluation
   A quiz can be developed from the material in the *Discussion* section.

DUTY AREA 3: OVERVIEW
Exploring Research in Agriculture

- **Competencies/Tasks**
  - 3.1 Explain the importance of agricultural research.
  - 3.2 Identify agricultural research in animal and plant science.
  - 3.3 Identify research in agricultural engineering technology.
  - 3.4 Explore career opportunities in agricultural research.

- **Lessons**
  - 3.1 The Importance of Agricultural Research
  - 3.2 Agricultural Research in Animal and Plant Science
  - 3.3 Research in Agricultural Engineering Technology
  - 3.4 Career Opportunities in Agricultural Research

- **Evaluation**

  Suggestions for evaluation appear at the end of each lesson. A sample quiz appears at the end of the duty area.

DUTY AREA 3
Exploring Research in Agriculture

Lesson 3.1 The Importance of Agricultural Research

Student Objectives

1. List two reasons why agricultural research is important.
2. List five benefits from agricultural research.
3. Name seven steps in solving a research problem.

References

Agricultural Scientists. Video. Lubbock: Creative Educational Video, 1987.
Agriscience Student Recognition Program. Alexandria: National FFA Organization.
Burton, L. DeVere. *Agriscience & Technology*. Albany: Delmar Publishers, Inc., 1992.
Think About It. Alexandria: National FFA Organization.
U.S. Department of Agriculture. Agricultural Research Service. *Agricultural Research*. Washington, DC: Government Printing Office.

Equipment, Supplies, Materials

handouts for group research projects (7VA 3.1- 3.4)
magazine articles on current research in agriculture
glossary of scientific terms (7VA 3.5)
transparency masters (7VA 3.6-3.8)

Presentation

A. Introduction
Agriculture research is responsible for advances in plant production, food preservation, personal health (medicines), and many other areas of everyday life. This lesson focuses on the role of agricultural research, its benefits, and basic aspects of research.

B. Motivation (select one)
1. Distribute articles on agricultural research to students. Have students read the articles and summarize them for the class. Note: articles could come from the "Ag Notes" section of *Agricultural Research* magazine.
2. Show the video *Agricultural Scientist*. If necessary, pause and discuss important points throughout the video.

C. Assignment
   1. Explain the steps of the research process (Question 4 of the *Discussion* section) using a simple example with students, such as posing the research question "Does adding cola to a jade plant affect its growth?" Have students explain how each of the research steps would apply to this example.
   2. Divide students into groups of four and assign each group a simple research project. Assign each student in a group one of the following duties:
      recorder/reporter
      principal investigator
      maintenance director
      materials manager

      Distribute the duty lists found in 7VA 3.1-3.4 to each group and discuss the responsibilities of each person.

D. Supervised Studyz
   Distribute a list of scientific terms (7VA 3.5) and discuss their definitions.

E. Discussion:
   1. *Question: What is agricultural research?*
      Answer: Agricultural research is the study of
      - how plants and animals respond to different stimuli
      - why they respond in the ways they do
      - how to solve problems using research information.

   2. *Question: Why is agricultural research important?*
      Answer:
      - to find new and better ways to feed and clothe people
      - to keep the animal industry healthy
      - to find answers to human health concerns

   3. *Question: What are some benefits that agricultural research has provided?*
      Answer:
      - new ways of packaging and preserving foods to increase shelf life
      - more efficient production from animals
      - plants that are resistant to disease and pests
      - ways to use computers to make meat-packing plants more efficient
      - cotton plants that produce longer fibers
      - plants that can survive harsh weather

      Have students add to this list from the articles read in the *Motivation* section.

   4. *Question: How is research in agriculture conducted?*
      Answer:
      - Identify the problem.
      - Review the literature: sources of information include encyclopedias, magazines, and books.
      - Form a hypothesis.
      - Prepare a proposal: a proposal is an outline or plan of how the experiment will be conducted.
      - Design the experiment.

- Collect the data and record all necessary information.
- Draw conclusions based on the data.
- Write a report.

Suggested Activity: Use transparency master 7VA 3.6 to discuss each of the steps involved in research. Use transparency masters 7VA 3.7-3.8 to introduce characteristics of different kinds of research projects.

F. Other Activities
1. Plan a field trip to a Virginia Agricultural Experiment Station.
2. Invite a guest speaker to discuss the benefits of agriscience research.
3. Read three magazine articles on agriscience research and summarize the articles.
4. Make a collage illustrating the benefits of agricultural research.
5. Have students bring in items which demonstrate the benefits of agricultural research.

G. Conclusion

Agricultural research has helped to increase food, crop, and animal production. It has also created more efficient methods of production, processing, and packaging. These improvements have helped make food and clothing more readily available and less expensive.

H. Evaluation

Develop questions for oral or written quizzes from the material covered in the *Discussion* section. Have students use a checklist prepared by the teacher to evaluate the group research projects in the *Assignment* section.

Lesson 3.2 Agricultural Research in Animal and Plant Science

Student Objectives

1. Identify significant developments in animal science research.
2. Identify significant developments in plant science research.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications*. Albany: Delmar, 1990.

Darrow, Edward E. *The Science Workbook of Student Research Projects in Food-Agriculture-Natural Resources*. Columbus: College of Agriculture, The Ohio State University, 1985.

Donahue, Roy L., and Ray V. Herren. *The Agricultural Dictionary*. Albany: Delmar Publishers, Inc., 1991.

U.S. Department of Agriculture. Agricultural Research Service. *Agricultural Research*. Washington, DC: U.S. Government Printing Office.

York, Walter. *Agriscience: Fundamentals and Applications Laboratory Manual*. Albany: Delmar Publishers, Inc., 1991.

Equipment, Supplies, Materials

Agriscience: Fundamentals and Applications: copies for each student
assignment handouts
project worksheets (7VA 3.9)

Presentation

A. Introduction

The previous lesson discussed the general importance of agricultural research and presented the basic steps involved in solving research problems. This lesson focuses on research developments in animal science and plant science. To provide background information about these developments, assign students to read pages 25-29 in *Agriscience: Fundamentals and Applications*. Review the material in these sections using the questions in the *Discussion* section.

B. Motivation

1. Have students list the food they ate the previous day. Have them place a star next to each food that came from animals, and a dot next to each food that came from plants. Use their lists to discuss the animals/plants used for food, the preparation involved, and the cost of items. Discuss the role of agricultural research in developing new products from animals, ways to make food less expensive, and new ways to produce and prepare various foods.
2. Have students bring in labels from cosmetics, shampoos, and other household items that contain animal or plant products. Discuss the role of agricultural research in developing these products.

C. Assignment

Have students complete a research project in plant or animal science. If time allows, have students complete a project in each area.

1. Review the seven steps of a research project covered in Lesson 3.1. Distinguish between experimental research projects and informational research projects (7VA 3.7-3.8), emphasizing the components of each. Students who select experimental projects should be sure to include a control group.
2. Have students select a project to complete. A list of suggested projects follows. A more complete list can be found in Darrow's *Science Workbook of Student Research Projects in Food-Agriculture-Natural Resources;* students interested in other areas of animal or plant science may choose topics of their own.

Suggested Topics in Animal Science

- The Difference Between Monogastric and Ruminant Digestion in Animals: Students research information on monogastric digestion (pigs) and compare it to a ruminant digestion (cattle). Possible projects include making a model of each type of digestion and labeling the parts; drawing a diagram; demonstrating parts with an actual digestive tract.
- Milk: The Process from Cow to Carton: Students diagram or show examples of the different stages in milk production from the time it is taken from the cow until it is on the grocery store shelf. Students could also show different milk products and the processes used to create each one.
- Animal Habitats: Students compare habitats such as mountains, plains, and valleys in different areas of the state or the U.S. and explain which animals live in each and why, i.e., due to climate variations, vegetation, etc.
- How Meat Is Cured: Students use a simple procedure to cure cubes of fresh pork using a mixture of salt, brown sugar, and sodium nitrate.
- The Effects of Food Additives on Taste: Students test the effects of various types of seasoning on meat. Students can experiment with the effects of 1) putting the additive on top of meat before cooking, 2) piercing the meat and letting the additive soak in before cooking (marinating), and 3) cooking the meat without additives.

Suggested Topics in Plant Science

- The Effects of Climate Conditions on Seed Germination: Students create different conditions for seeds to germinate in, such as heat, cold, freezing, wetness, dryness, in light, without light. Students keep track of how each condition affects germination.
- How Terrariums Work: Students research how terrariums work and the different types of containers and media that can be used.
- Plant Parts and Functions: Students illustrate or make models of plant parts and research the functions of each part. Different types of plants can be used to demonstrate variations.
- Propagation: Students research, illustrate, and experiment with various propagation methods, such as stem cuttings, leaf cuttings, seeds, and tissue cultures.

3. Set up a schedule indicating when students must complete each portion of their projects. (See sample schedule 7VA 3.9.) Note that projects in plant science may take longer because of the length of time required to observe differences.
4. Have students give a 10-minute presentation on their projects to the class.

D. Supervised Study
Visit the school library and/or allow students time during class to look through resources (encyclopedias, magazines, books, video tapes, newspapers) for information on their project topics. Ask the librarian to set aside related materials in advance.

E. Discussion

1. *Question: What* is *meant by the term* selection *in agricultural research?*
Answer: *Selection* means choosing the animals or plants that will be used to produce the next generation.

2. *Question: What is the* Beltsville Small White turkey, *and why was it developed?*
Answer: The *Beltsville Small White turkey* was developed at the Beltsville Agricultural Research Center in Maryland to meet consumer demands for a smaller (8-12 pounds) turkey (8-12 lbs). Because American were having smaller families, the common 25-30 lb. turkeys were no longer needed.

3. *Question: What did Gregor Johann Mendel research, and why is his work important?*
Answer: Mendel is best known for his research with pea plants. His studies showed that various traits in plants and animals occur in pairs (such as tall/short, dark/light), with one trait of the pair being dominant. For example, crossing a short pea plant with a tall pea plant results in a tall pea plant because tallness is a dominant trait. This discovery is the basis for modern study of heredity in plants and animals, including humans.

4. *Question: What human health concerns has animal science research addressed?*
Answer: Medical research has shown that high blood pressure and heart disease are reduced if fat is decreased in the diet and if cholesterol levels are controlled.

5. *Question: What common household item was invented through agriscience research before World War II?*
Answer: The aerosol can was developed to control mosquitoes spreading malaria to soldiers in the tropics.

6. Question: *What diseases in animals have agriscientists controlled?*
Answer:
   - Mastitis (an infection of milk secreting glands) in dairy cattle: This disease reduces milk production and increases the cost of milk to the consumer. It has been reduced by inserting plastic loops into cattle udders.
   - Coccidiosis (a poultry disease): A parasite which helps poultry develop an immunity to coccidiosis has been genetically engineered by agriscientists.

7. *Question: What new method is being used to discover nutrient deficiencies in fields of corn and soybeans?*
Answer: Lasers from satellites are being used to monitor wavelengths that indicate deficiencies of potassium, nitrogen, and other nutrients.

F. Other Activities (select one)
   1. Have a class or department Agriscience Fair using competed research projects. Award all students with a ribbon.
   2. Work with the science teacher on project fair guidelines and have a combined Agriculture/Science Fair. Award all students with a ribbon.

G. Conclusion
   Agriscience research benefits humans medically and economically. It has increased scientific knowledge of health concerns and has helped make food more readily available and less expensive.

H. Evaluation
   The sample evaluation form (at the end of 7VA 3.9) can be used to evaluate research projects. Due dates and points awarded can be altered depending on the length of the course and the weight assigned to the project grade.

Lesson 3.3 Research in Agricultural Engineering Technology

Student Objective

Identify significant developments in agricultural engineering technology.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications*. Albany: Delmar Publishers, Inc., 1990.

Donahue, Roy L., and Ray V. Herren. *The Agricultural Dictionary*. Albany: Delmar, Publishers, Inc. 1991.

U.S. Department of Agriculture. Agricultural Research Service. *Agricultural Research*. Washington, DC: U.S. Government Printing Office.

Equipment, Supplies, Materials

Agriscience: Fundamentals and Applications: a copy for each student
assignment handouts
project worksheets (7VA 3.9)

Presentation

A. Introduction

Previous lessons have covered research methods and research in plant and animal science. This lesson examines the significance of research in agriscience engineering technology. To provide background information about these developments, assign students to read pages 25-29 in *Agriscience: Fundamentals and Applications*. Review this material using the questions in the *Discussion* section.

B. Motivation

Have students list what they are wearing, and place a star by clothing made from cotton and leather. Ask students to explain how balls of cotton become blue jeans, and how cattle hide becomes a soft jacket or a boot. Discuss the role that agricultural engineering research plays in making machines that produce food and clothing.

C. Assignment

Have students develop an agricultural engineering invention.

1. Review the seven steps of a research project covered in Lesson 3.1. Review current agricultural inventions.
2. Have students select a project to complete. They may use an idea of their own, or choose from the following suggestions. Models may be included.
   - a hay baler that automatically stacks hay
   - an automatic orange peeler that also removes the white
   - a machine that captures methane gas and turns it into electricity

3. Set up a schedule of due dates for the various segments of student projects. (See sample schedule 7VA 3.9.)
4. Have students give a 10-minute presentation on their project to the class. Include the invention's benefits, its approximate cost, and how it differs from existing machines or methods.

D. Supervised Study
1. Visit the school library and/or allow students time during class to look through resources (encyclopedias, magazines, books, video tapes, newspapers), for information on their project topics. Ask the librarian to set aside related materials in advance.
2. Have students complete a bibliography.

E. Discussion
Question: *Who are some inventors of agricultural machinery, what did they invent, and what was the function of their invention?*
Answer:

Inventor	Machine	Function
McCormick	reaper	cuts small grain
Deere	moldboard plow	plows prairie in the Midwest
Whitney	cotton gin	separates cotton seed from cotton fiber
Glidden	barbed wire	discourages livestock from touching fence
Quincy	corn picker	separates ears of corn from stalks

Discuss how the work was done before this invention.

F. Other Activities
1. Have a class or department *Engineering Fair* to showcase completed projects. Award all students a ribbon.
2. Invite an agricultural engineer to talk about how new products are invented and/or made.

G. Conclusion
Research in agricultural engineering technology, like that in plant and animal science, can provide economic benefits, such as helping to make food and clothing more readily available and less expensive.

H. Evaluation
The sample evaluation form (at the end of 7VA 3.9) can be used to evaluate research projects. Due dates and points awarded can be altered depending on the length of the course and the weight assigned to the project grade.

Lesson 3.4 Career Opportunities in Agricultural Research

Student Objective

Name five career opportunities in agricultural research.

References

Burton, L. DeVere. *Agriscience & Technology*. Albany: Delmar Publishers, Inc., 1992.

Cooper, Elmer L. *Agriscience: Fundamentals and Applications*. Albany: Delmar Publishers, Inc., 1990.

Donahue, Roy L., and Ray V. Herren. *The Agricultural Dictionary*. Albany: Delmar Publishers, Inc., 1991.

Equipment, Supplies, Materials

magazines
poster board
resource materials

Presentation

A. Introduction

Agricultural research in plant science, animal science, or agricultural engineering is an exciting and innovative career area. The results of research in agriculture can have an enormous impact on society.

B. Motivation

Have students name as many career areas as they can remember from previous lessons in agricultural research.

C. Assignment

Divide students into groups and have each group develop a poster displaying at least 10 different careers in agricultural research with captions beneath each picture explaining the career. Pictures can be cut from magazines to illustrate these careers. Other career information can be found in encyclopedias, books, and newspapers. Have each group give a five-minute presentation to the class on its career poster.

D. Discussion

1. *Question: What are some research areas in agriculture?*

   Answer:

   animal production
   plant production
   soil and water management
   agricultural mechanics
   agricultural processing
   agricultural marketing
   natural resources

Ask students to add others to the list. Discuss areas covered in the assignment.

2. Question: *What are examples of research-related careers in agriculture?*
   Answer:
   - Animal or plant: geneticist, seed analyst, entomologist, veterinarian, aquaculturist, plant pathologist
   - Soil and water: hydrologist, soil conservationist, agronomist
   - Mechanics: agricultural engineer with specialization in energy and power, alternative energy sources, buildings and structures.
   - Processing: food scientist, engineering with emphasis on: processing techniques, packaging, new uses of products
   - Marketing: market analyst
   - Natural resources: ecologist, wildlife biologist, dendrologist, environmentalist

   Ask students to be specific about what each career involves.

E. Other Activities (select one)
   1. Have students individually research one career in agricultural research.
   2. Have each student create a poster of careers in agricultural research.
   3. Have students interview someone who works in an agricultural research career.

F. Conclusion
   Agricultural research has many career opportunities because it is a field full of challenging problems and innovative solutions.

G. Evaluation
   1. Give students oral quiz after each presentation.
   2. Give students a written quiz on what they learned from the career posters and the various careers studied.

Duty Area 3 Evaluation: Exploring Research in Agriculture

Evaluation for this unit will be based on the development of either an experimental or informational science fair project. Listed below are some suggested topics. Coordinate with the science teacher and others in providing assistance for students. Use the materials following this page to organize and carry out the projects.

Quizzes can be developed from materials in each lesson.

Possible Projects

What do plants obtain from the soil?

Does magnetism affect plant growth?

What is inside a corn stalk?

What energy is produced by swelling seeds?

Do pesticides used by farmers kill fish?

Discuss flowers as chemical indicators.

Describe freshwater protozoa and their environment.

What can absorb oil from water?

Explain asexual reproduction through tissue culture.

Identify wildlife population management.

Describe filtration and absorption capacities of forest soils for polluted water.

Demonstrate and explain how to do tissue cultures.

Explain the effect of environmental and chemical factors on population growth.

Recorder/ Reporter

1. Collects data
2. Checks all measurements
3. Records data from investigation
4. Checks results with principal investigator
5. Turns in results to teacher
6. Gives oral report on the investigation if necessary

Principal Investigator

1. Takes charge of team
2. Helps with work of investigation
3. Reads written instructions
4. Appoints helpers
5. Leads group discussions
6. Asks teacher questions
7. Checks results for accuracy

Maintenance Director

1. Keeps work area clean
2. Takes charge of clean-up
3. Takes charge of group safety
4. Obtains necessary safety equipment for investigation
5. Makes sure group members are following safety rules

Materials Manager

1. Collects equipment and supplies
2. Sets up equipment
3. Makes observations, works the equipment, and takes measurements
4. Informs principal investigator of broken equipment or missing materials
5. Puts up equipment and materials when finished

Agriscience Project

1. Identify problem.
2. Review literature.
3. Form hypothesis.
4. Prepare proposal.
5. Design experiment.
6. Collect data.
7. Draw conclusions.
8. Write your report.

Experimental Projects

1. Establish control group.
2. Work with effects.
3. Change variables.

Informational Research Projects

1. How to
2. Did you know?
3. Comparative

Agriscience Project

_____

Name

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Project Title: _____

Description: Summarize in one paragraph your Agriscience Activity or Project.

Outline of Steps to be Followed to Complete the Agriscience Project

Use this page to outline the steps to be followed to complete the Agriscience Project. Include materials and, resources needed, and any other information appropriate to the project.

Title of Project: _____

Record of Research Conducted on Agriscience Project

In the space provided below, write down the information gathered through research from the library, correspondence, or other sources.

Title of Project

Bibliography

Author _____

Name of source (book) used _____

Title of Article _____

Volume or Year of Publication _____

Pages used _____

Information found in reference

_____

_____

_____

_____

_____

Bibliography

Author _____

Name of source (book) used _____

Title of Article _____

Volume or Year of Publication _____

Pages used _____

Information found in reference

_____

_____

_____

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Bibliography

Author _____

Name of source (book) used _____

Title of Article _____

Volume or Year of Publication _____

Pages used _____

Information found in reference

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Bibliography

Author _____

Name of source (book) used _____

Title of Article _____

Volume or Year of Publication _____

Pages used _____

Information found in reference

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_____ 72

Final Report on the Agriscience Project

Write a summary and evaluation of the Agriscience Project. Include a detailed explanation of the project, results of any experiments, information and data used to complete the project, and a brief conclusion.

Title of Project

74

Assignment Sheet (Example)

	Assignment	Date Due	Possible Points	Earned
A.	Paragraph explanation of project plans	Sept. 15	20	
B.	Bibliography/Information	Sept. 30	100	
C.	One page outline of steps to complete project	Oct. 10	20	
D.	Written report/summary (minimum 1 page)	Nov. 1	100	

Duty Area 4: Overview
Exploring Plant Science

- **Competencies/Tasks**
  - 4.1 Identify the economic importance of agricultural crops.
  - 4.2 Describe the process of photosynthesis in plants.
  - 4.3 Identify methods of plant reproduction.
  - 4.4 Describe proper watering and fertilization of plants.
  - 4.5 Explain how to identify and label plants.
  - 4.6 Describe methods of planting or transplanting.
  - 4.7 Explain the use of hydroponics in grouping plants.
  - 4.8 Discuss new technologies in plant science.
  - 4.9 Identify career opportunities in plant science.

- **Lessons**
  - 4.1 The Economic Importance of Agricultural Crops
  - 4.2 The Process of Photosynthesis in Plants
  - 4.3 Methods of Plant Reproduction
  - 4.4 Proper Watering and Fertilization of Plants
  - 4.5 Identifying and Labeling Plants
  - 4.6 Methods of Planting or Transplanting
  - 4.7 The Use of Hydroponics in Growing Plants
  - 4.8 New Technologies in Plant Science
  - 4.9 Career Opportunities in Plant Science

- **Evaluation**

  Suggestions for evaluation appear at the end of each lesson. A sample quiz appears at the end of the duty area.

Duty Area 4
Exploring Plant Science

Lesson 4.1 The Economic Importance of Agricultural Crops

Student Objectives

1. List the three main reasons why crops are important.
2. List major crop commodities and give examples of each.
3. Describe the conditions necessary to grow a crop successfully.
4. Explain the role of agriscience in the production of crops.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications*. Albany: Delmar Publishers, Inc., 1990.

Equipment, Supplies, Materials

agricultural magazines
reference books

Presentation

A. Introduction

Agricultural crops play an important economic role. This unit looks at significant crops in the United States and the world, conditions necessary for growing crops, and the role of agriscience in crop production.

B. Motivation

1. Have students find and read magazine articles on crops.
2. Show production statistics for a local crop over a period of time.
3. Discuss what life would be like without certain crops such as wheat.

C. Assignment

1. Have students form groups and list as many different crops as possible in a given period of time.
2. Have students form groups and research a certain crop (history, growth, scientific study).
3. Have students investigate agriculture in another state and determine the major crops grown in that state.

D. Discussion

1. Question: *Why are crops important?*
   Answer: food, fiber, feed for livestock

2. Question: *What are some major crop commodities and examples of each?*
   Answer:
   - Grains: wheat, rice, corn
   - Oil crops: soybeans, peanuts, sunflower seed
   - Sugar crops: sugar cane, sugar beets
   - Citrus: oranges, lemons, grapefruit
   - Tree fruits: apples, pears, peaches
   - Vegetables:
     cool climate: broccoli, cabbage, potatoes
     warm climate: tomatoes, sweet corn, beans
   - Specialty crops: cotton, tobacco

3. Question: *What factors are important in growing crops?*
   Answer:
   - Climate: length of growing season, average yearly rainfall, average tememperatures, humidity, and prevailing winds
   - Soil: consider soil pH, soil type, soil depth, and soil response to fertilizer
   - Demand or markets available for the crop to be produced
   - Labor requirements and availability of labor
   - Machinery or equipment necessary to grow the crop
   - Availability of land
   - Pest problems
   - Expected yields
   - Production costs (Can a profit be expected?)

E. Other Activities

1. Invite an extension agent to discuss new technologies in crop production.
2. List the crops grown locally. Using current market values and production statistics (obtained from the Virginia Cooperative Extension Service), determine the value of all major crops grown in the local county.

F. Conclusion

The production of field crops creates more income for agriculturists in the U.S. than any other production enterprise. Slightly more than 20% of the land in the U.S. is used for crop production.

G Evaluation

Quiz and test material can be developed from the lesson. Other research or group activities can be evaluated by the instructor. A duty area evaluation is included at the end of the duty area.

Lesson 4.2 The Process of Photosynthesis in Plants

Student Objectives

1. Describe the process of photosynthesis using the formula for photosynthesis.
2. Identify the chemical compounds involved in photosynthesis.
3. Describe the importance of photosynthesis to both plant and animal life.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications*. Albany: Delmar Publishers, Inc., 1990.

Heimler, Charles H. *Focus on Life Science*. Columbus: Charles E. Merrill, 1981.

Equipment, Supplies, Materials

overhead projector
green plants

Presentation

A. Introduction

Plants that have the ability to manufacture sugars and starches feed all the other plants and animals of the world. Without these plants, life would end because they are the beginning of the food chain. This lesson examines the process that makes it possible for plants to feed other living organisms.

B. Motivation

1. Discuss how a plant gets food to live.
2. Discuss what would happen to animals if there were no plants.

C. Assignment

1. Write a short paper describing how plants and animals help each other live.
2. In small groups, have students list the differences between plants and animals.

D. Discussion

1. Question: *What is photosynthesis?*
   Answer: Photosynthesis is a chemical change that produces food in green plants. In photosynthesis, carbon dioxide, gas, and water are combined to produce sugar. Sunlight supplies the energy for the chemical change.

2. Question: *Why is photosynthesis important?*
   Answer:
   - It is the most important chemical process in the atmosphere.
   - It allows plants to make their own food.
   - It provides oxygen for animals.
   - It makes complex sugars, starches, fats, and proteins.

3. Question: *What is the formula for photosynthesis?*
   Answer:
   light
   $6CO_2 + 6H_2O$----------$C_6H_{12}O_6 + 6O_2$
   chlorophyll
   CO_2= carbon dioxide
   H_2O= water
   light = sunlight
   chlorophyll = green in plants
   $C_6H_{12}O_6$= sugar
   O_2 = oxygen
   Using the formula, describe the process of photosynthesis.

E. Other Activities
   1. Have students plan an agriscience project about photosynthesis.
   2. Conduct an agriscience experiment in the classroom or the greenhouse.
   3. Construct a bulletin board display showing the cross section of a leaf; label the leaf parts.

F. Conclusion
   Almost all food on earth originates from green plants. Green plants carry on photosynthesis which creates food for the plant and oxygen for animals.

G. Evaluation
   A test, quizzes, or a writing assignment can be used to evaluate the material in this section.

Lesson 4.3 Methods of Plant Reproduction

Student Objectives

1. Distinguish between sexual and asexual reproduction.
2. List four types of asexual reproduction and describe each one.
3. Prepare a stem cutting from a house plant.
4. Describe the procedure for propagating plants by tissue culture.

References

Ames, Barbara E. *Illustrated Horticulture.* Richmond: Vocational Education Curriculum Center, 1983.

Cooper, Elmer L. *Agriscience: Fundamentals and Applications.* Albany: Delmar Publishers, Inc., 1990.

Plant Propagation Video Series: Video. Vocational Education Productions. San Luis Obispo: California Polytechnic State University.

Equipment, Supplies, Materials

seeds
house plants
soil
pruners
rooting hormone
tissue culture kit
TV/VCR

Presentation

A. Introduction

Plant reproduction is a valuable aspect of agriscience research. By improving their understanding of this process, scientists can create new and better species. The result is that plants are able to survive less desirable conditions, thus increasing food production for the world.

B. Motivation

1. Show video on plant reproduction.
2. Demonstrate the proper method of taking a cutting from a plant.

C. Assignment

1. Choose a form of propagation to research and demonstrate before the class.
2. In small groups, list the crops that are grown commercially in your area. What propagation method is used for each?
3. Research the necessary environment needed to germinate different seeds.

D. Discussion

Plant propagation or reproduction is the process of increasing the number of species.

1. Question: *What are the types of plant propagation?*

   Answer:

   1. Sexual: involves the floral (flower) parts of plants to form seeds.
   2. Asexual: utilizes a part or parts of one parent plant.
      - Cuttings: A part is cut from the parent plant and forms roots.
      - Layering: A part of the plant forms new roots while still attached to the parent plant.
      - Division: A plant is separated into smaller parts (including roots).
      - Tissue culture: A very small part of a plant is used to grow a new plant in a sterile environment. Tissue culture is also known as micropropagation. Many plants can be grown from a single leaf. However, all of the equipment must be sterile. If not, bacteria and fungus will grow in unclean culture tubes.

   List nursery plants that are available locally, and indicate the method of propagation that is best suited for each.

Plant	Propagation Method
raspberries	layering
azaleas	layering
dogwood tree	layering
gladiolus	division
tulips	division
carrots	tissue culture
African violets	division
rhododendrons	cuttings
corn	seeding
tomatoes	seeding

E. Other Activities

1. Conduct an agriscience project that would study rooting techniques.
2. Invite a local garden club member to speak about propagation.
3. Set up a tissue culture experiment using the directions available from the Virginia Cooperative Extension Service.
4. Visit a local greenhouse or nursery to learn more about propagation.
5. Create a bulletin board to show the parts of a flower and the process of pollination.

F. Conclusion

Plants can be propagated by forming seeds through flowering or by forming a new plant from the parent. With new agriscience technologies, an increasing number of plants are formed using tissue culture.

G. Evaluation

Quiz and test material can be developed from the lesson. Also, other research or group activities may be used for evaluation.

Lesson 4.4 Proper Watering and Fertilization of Plants

Student Objectives

1. Identify the two basic forms of fertilizer.
2. List the representative nutrients in a fertilizer container.
3. List two important functions each of: nitrogen, phosphorus, and potassium.
4. Describe the basic procedure for watering a plant.

References

Ames, Barbara E. *Illustrated Horticulture.* Richmond: Vocational Education Curriculum Center, 1983.

Cooper, Elmer L. *Agriscience: Fundamentals and Applications.* Albany: Delmar Publishers, Inc., 1990.

Equipment, Supplies, Materials

granular fertilizer
soluble fertilizer
water
plants
magazines
soil test results
house plant guides

Presentation

A. Introduction

Water is an essential ingredient for the growth of any living organism. Living things also need nutrients on a regular basis. In addition to water, plants also need fertilizers for good health and growth.

B. Motivation

1. Discuss the need for food in people, animals, and plants.
2. Water plants using a mixture of soluble fertilizer.
3. Show a filmstrip or video about plant care.
4. Compare the value and use of a healthy plant vs. an unhealthy plant.

C. Assignment

1. Research a type of house plant and determine its water and fertilizer requirements.
2. Read a magazine article about irrigation.
3. Determine the percentage of N, P, and K from a fertilizer bag.
4. Read a soil sample report and determine the fertilizer requirements.
5. Create an agriscience project studying the fertilization of plants.

D. Discussion

1. Question: *What are the two basic types of fertilizer?*
   Answer:
   - Granular: dissolves gradually and releases nutrients over weeks or months
   - Soluble: dissolves in water for immediate use by the plant

2. Question: *What do the numbers on a fertilizer package mean?* (example: 10-10-10)
   Answer: They represent the percentages of nitrogen, phosphorus, and potassium (N, P, K) in the mix. (example: 10% N, 10% P, 10% K)

3. Question: *What is the importance of N, P, and K?*
   Answer:
   N - Nitrogen promotes
   dark green foliage
   rapid growth
   increased protein.
   P- Phosphorus promotes
   early root formation
   vigorous start
   flowering
   maturity
   winter hardiness
   conversion of sugar to energy.
   K- Potassium promotes
   disease resistance
   strong stems
   winter hardiness
   vigor.

4. Question: *What is the purpose of different strengths of fertilizer?* (example: 5-10-10, 6-10-4, 0-15-309)
   Answer: Different strengths of fertilizer are designed to meet the different needs of plants. Not all plants require the same nutrients, and some soils provide more of one major nutrient than others. Fertilizer is used to balance out the differences.

5. Question: *What is the leading cause of unhealthy plants?*
   Answer: Overwatering! Facts about proper watering of plants:
   - As with other environmental factors (light, temperature, etc.) each plant varies in its water requirements.
   - Usually, it is best to water a plant when the soil becomes slightly dry.
   - The basic rule of watering plants is to wet the soil in the pot until excess water drains from the bottom.
   - Most plants do best if allowed to dry between watering times.

E. Other Activities

1. Create a computer program that would determine the amount of soluble fertilizer needed for a given amount of water.
2. Develop a fact sheet about the water, fertilizer, light, and temperature needs of the more familiar plants found in your area.

3. Take a soil sample from a lawn or home garden.
4. Visit a local nursery or greenhouse to view different types of watering systems.

F. Conclusion
Proper watering and fertilization are essential for the good health and growth of plants. For optimum results, water and fertilize each plant according to its individual needs.

G. Evaluation
A test, quizzes, or a project assignment can be used to evaluate the material in this unit.

Lesson 4.5 Identifying and Labeling Plants

Student Objectives

1. Identify 10 forest trees.
2. Identify 10 house plants.
3. Identify five vegetables or nursery plants.
4. List five ways to identify plants.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications*. Albany: Delmar Publishers, Inc., 1990.

Reiley, H. Edward & Carroll L. Shry, Jr. *Introductory Horticulture*. Albany, Delmar, 1991.

Techniques in Plant Identification (Video). Vocational Education Productions. San Luis Obispo: California Polytechnic State University.

Walls, Bryn. *The Visual Dictionary of Plants*. New York: Dorling Kindersley, 1992.

Equipment, Supplies, Materials

plants
seeds
plant and forestry identification books
TV/VCR

Presentation

A. Introduction

There are more than 300,000 species of plants, each of which has distinct characteristics. These plants can adapt to survive in a wide range of habitats. This lesson explains how to label parts of plants in order to identify them.

B. Motivation

1. Show a video that explains how to identify plants.
2. Show a variety of plants to identify.
3. Use a field guide to identify leaves of forest trees.
4. List plants found locally.

C. Assignment

1. Research a plant species, including its origin and importance.
2. Make a poster depicting a plant species.
3. Identify 10 house plants.
4. Identify 10 forest trees.
5. Collect and press 10 leaves from different forest trees.
6. Identify five vegetable or nursery plants.

D. Discussion

1. Question: *What are some ways to identify plants?*
   Answer:
   leaf
   flower
   fruit
   roots
   shape
   seed
   stem

2. Question: *What are some general types of plants?*
   Answer:
   house plants
   trees
   flowers
   vegetables
   nursery plants

E. Other Activities

1. Make a leaf press for drying and displaying leaves.
2. Hold a plant and seed identification contest.
3. Judge a class of four plants.
4. Make a bulletin board that shows ways to identify plants.
5. Have a local extension agent or nursery grower present a program on plant identification.

F. Conclusion

In order to successfully grow plants, identifying the species is necessary. Once the identification is made, proper care can be given to the plant.

G. Evaluation

A test, quiz, or an identification exercise can be used to evaluate the material in this unit.

Lesson 4.6 Methods of Planting or Transplanting

Student Objectives

1. Identify three methods of planting seeds.
2. List the steps for planting seeds.
3. Explain what it means for a plant to be root-bound.
4. Describe the process of transplanting.

References

Ames, Barbara E. *Illustrated Horticulture*. Richmond: Vocational Education Curriculum Center, 1983.

Cooper, Elmer L. *Agriscience Fundamentals and Applications*. Albany: Delmar Publishers, Inc., 1990.

Herren, Ray V. & Roy L. Donahue. *The Agriculture Dictionary*. Albany: Delmar, 1991.

How to Grow and Nurture Seedlings. (Video). Columbus: Ohio Agricultural Curriculum Materials Service.

Equipment, Supplies, Materials

seeds
soil
plant flat
flat pack
flower pots or hanging baskets
TV/VCR

Presentation

A. Introduction

Most flowers and vegetables are grown from seed. Sometimes the seeds are sown where the plants will grow. However, seedlings and other plants must be moved from greenhouse or nursery setting to a new location. Plants that live in containers also need to be transplanted to allow more room for root growth. This lesson explores methods of planting or transplanting.

B. Motivation

1. Show a root-bound plant and discuss with students the effects of this condition on the plant.
2. Show video on planting seeds.
3. Demonstrate transplanting and planting seeds.

C. Assignment

1. Read an article about planning a home garden.
2. Plant seeds in a flat.
3. Transplant seedlings from a flat to a flat pack.
4. Determine from a given set of pictures or plants which ones are root-bound.
5. Make a list of seeds that can be bought in your area.

6. Make a list of bedding plants available locally.
7. Create an agriscience project that studies planting or transplanting.
8. Research the planting process of different flowers or vegetables, using seed packages.

D. Discussion

1. Question: *What are some methods of planting seeds?*
   Answer:
   rows
   hills
   broadcasting
   After discussing with students the various methods of planting seeds, have students list types of plants that are more suitable for each of the above methods.

2. Question: *How should seeds be planted?*
   Answer:
   - Follow directions on the seed package to plant at the correct depth, and space the seeds properly.
   - Level and firm the soil surface after planting.

3. Question: *Why would plants need to be transplanted?*
   Answer:
   - to move vegetables or flowers from a greenhouse to a garden
   - to move trees and shrubs from a nursery to a home landscape
   - to move root-bound plants to a larger pot

4. Question: *What does root-bound mean?*
   Answer: "Root-bound" is when the roots of a plant completely fill a container and surround the soil ball, restricting normal growth.

5. Question: *What are the steps for transplantation?*
   Answer:
   1. Dig a hole that is slightly larger than the root ball. To move a plant to another pot, find a container that is about 2" larger than the previous pot.
   2. Add some fresh soil on the bottom.
   3. Move the plant to the new location, planting it slightly deeper than it grew in its original container.
   4. Put soil around the plant and firm slightly.
   5. Water the plant.
   6. Cover the area around the plant with dry soil or mulch to prevent the loss of moisture.

E. Other Activities

1. Develop a fact sheet on the depth, spacing, and planting times of the seeds most commonly found locally.
2. Plan a flower or vegetable garden for home.
3. Invite a landscaper to talk about transplanting techniques for perennials.
4. Conduct an agriscience experiment on planting seeds or transplanting plants.
5. Schedule bedding plants to be grown in the greenhouse for spring transplanting to a home garden.

F. Conclusion
Maintaining a successful garden and landscape requires not only knowing the proper methods of planting seeds and transplanting plants, but also skill and patience. This lesson discussed methods of planting and transplanting.

G. Evaluation
A test, quizzes, or a project assignment can be used to evaluate the material in this unit.

Lesson 4.7 The Use of Hydroponics in Growing Plants

Student Objectives

1. Describe the working operation of a hydroponics unit.
2. List three advantages of growing plants hydroponically.
3. List four general facts about soilless farming.
4. Identify the parts of a hydroponic unit.
5. List the three major nutrient requirements.

References

Hydroponics: An Introduction to Soilless Agriculture. (Video). Columbus: Ohio Agricultural Curriculum Materials Service.

Mullins, Jimmy. *Hydroponics Curriculum.* Petersburg,: Virginia State University, Virginia Cooperative Extension Service, 1989.

Equipment, Supplies, Materials

hydroponic unit
oasis cubes
seeds
nutrients
TV/VCR

Presentation

A. Introduction

This lesson defines hydroponics and discusses what is needed to grow plants hydroponically, equipment necessary to set up a hydroponics unit, general facts about hydroponics, and the advantages of growing plants hydroponically.

B. Motivation

1. Show video on hydroponics.
2. Demonstrate a working hydroponic system.

C. Assignment

1. Have students research the history of growing plants without soil.
2. Have students design a system for growing plants hydroponically.
3. Have students read an article about a successful hydroponic farming operation.

D. Discussion

1. Question: *What is hydroponics?*
   Answer: Hydroponics is the science of growing plants in water rather than soil.

2. Question: *What is needed to grow plants hydroponically?*
   Answer:
   water
   nutrients

growing media (e.g., oasis cubes, sand, sawdust)
pump
reservoir

3. Question: *What nutrients are needed for a hydroponic unit?*
Answer:
soluble fertilizer
calcium nitrate
magnesium sulfate (Epsom salt)

4. Question: *What are the parts of a hydroponic unit?* (draw or show)
Answer:
submersible pump
hose
header pipe
cutters or PVC pipe
drainage trough
reservoir

5. Question: *How does a hydroponics system work?*
Answer: The nutrient solution is pumped from the reservoir through a hose to the header pipe. There, the solution is distributed to the gutters or PVC pipes. The nutrients then flow down (across the root area) to the drainage trough. From there, the water solution flows back to the reservoir to complete the cycle.
General Facts About Hydroponics:
- Any plant can be grown in a hydroponic system.
- About one fourth as much water is needed as in conventional farming.
- The production of plants can be six times as great as conventional growth.
- Almost any type of hydroponic system will produce acceptable growth.
- Hydroponic systems will be used to grow food on U.S. space stations.
- Construction of a hydroponic system is easy and inexpensive.

Advantages of Hydroponics:
- The taste, quality, appearance, uniformity, and shelf life of hydroponically grown vegetables are superior.
- No sterilization of growing media is required.
- Nutrition is easily controlled within the reservoir.
- No weeds or soil diseases exist, and cultivation is unnecessary.
- Uniform water is available to plants.
- Less water and fertilizer is needed.
- Root zone heating is possible by heating the nutrient solution.

E. Other Activities
1. Visit a greenhouse or research facility that uses hydroponics.
2. Have students design a hydroponics system that could be used in a space station with no gravity.
3. Test and adjust the pH of the nutrient solution.
4. Conduct an agriscience project with hydroponics.
5. Have students bring in seeds to be planted hydroponically.
6. Construct a small hydroponics unit or obtain a hydroponics kit.

F. Conclusion

Plants can be grown without soil using hydroponics. Although hydroponics has been a science for hundreds of years, it has recently become an accepted form of crop production. It can be a highly profitable form of producing crops, especially fresh vegetables. Hydroponics could also be the answer to many of the world's land and food shortage problems.

G. Evaluation

A test, quizzes, writing assignments, or design problems can be used to evaluate the material in this section.

Lesson 4.8 New Technologies in Plant Science

Student Objectives

1. Identify five new technologies in plant science.
2. List three effects of plant science research on farmers.
3. List three effects of plant science research on consumers.

References

Ball, Vic. *Ball Red Book.* Englewood Cliffs: Prentice-Hall, Inc., 1985.

Burton, L. DeVere. *Agriscience and Technology.* Albany: Delmar Publishers, Inc., 1992.

Cooper, Elmer. *Agriscience: Fundamentals and Applications.* Albany: Delmar Publishers, Inc., 1990.

Plant Your Future. (Video). Vocational Education Productions. San Luis Obispo: California Polytechnic State University.

Reiley, H. Edward & Carroll L. Shry, Jr. *Introductory Horticulture.* Albany: Delmar Publishers, Inc., 1991.

Equipment, Supplies, Materials

video
filmstrip
magazines
agriscience books
agriscience models or kits
TV/VCR

Presentation

A. Introduction

New technologies in plant science are emerging every day. Most of these technologies have to do with producing plants faster, better, and with fewer chemicals and labor. Agriculturalists must keep up with the latest developments in order to remain competitive.

B. Motivation

1. Discuss some new technologies in plant science that have been covered in agriscience class.
2. Show a video on new discoveries in plant science.
3. Explain a successful agriscience project that studied plants.

C. Assignment

1. Have students read a magazine article about a new development in plant science.
2. Have students research and report on a new technology in plant science.
3. Have students design an agriscience project that studies a new invention in plant science.
4. Have students write a paper about what agriculture might be like in 20 years.

D. Discussion

1. Question: *What are some new technologies in plant science?*
   Answer:
   tissue culturing
   aquaponics
   ice-minus bacteria
   integrated pest management
   tissue analysis

2. Question: *What are the effects of these new developments on farmers?*
   Answer:
   Tissue culturing
   Farmers can have quick access to superior plants because thousands of new plants identical to the parent plant can be produced quickly.
   Hydroponics
   Hydroponics involves the production of plants without soil. This process allows farmers to produce crops even when the soil is unsuitable or when there is no soil.
   Ice-minus bacteria
   The development of this bacteria allows plants to tolerate temperatures several degrees below freezing. It reduces the chances of farmers losing their entire crops to periods of freezing.
   Integrated pest management
   This allows farmers to destroy harmful insects while providing some protection of useful insects. It limits the amount of chemicals used to destroy insects by relying more on natural insect enemies.
   Tissue analysis
   This allows a farmer to determine nutrient problems in plants before they become stressed and damaged. It helps to prevent reductions in crop yields.

3. Question: *What are the effects of these developments on consumers?*
   Answer:
   reduction in food cost
   continued supply of food
   safer environment
   higher quality product

E. Other Activities

1. Make a bulletin board that shows new technologies in plant science.
2. Set up a small hydroponics system for display at a local library or schoolboard office.
3. Set up a field trip to a research station or local farm that is implementing new forms of agriculture.

F. Conclusion

In order to protect the fragile environment and to meet the needs of a changing world, the science of agriculture must also change. Agriscientists must continue to research and develop new techniques of producing food and fiber for a growing planet.

G. Evaluation

A test, quizzes, project, or writing assignment can be used to evaluate the material in this unit.

Lesson 4.9 Career Opportunities in Plant Science

Student Objectives

1. Explain what a career in a plant science is.
2. Describe opportunities for careers in plant science.
3. List activities to help prepare for a career in plant science.
4. List five careers in plant science and the educational requirements for each.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications*. Albany: Delmar Publishers, Inc., 1990.

Growing Futures–Career Opportunities in the Green Industry. (Video). Professional Plant Growers Association. Columbus: Ohio Agricultural Education Curriculum Materials Service, 1990.

Hoover, Norman K. *Handbook of Agricultural Occupations*. Albany: Delmar, 1990.

Equipment, Supplies, Materials

newspapers
magazines
job skills survey
job application
video or filmstrip
textbooks that include agriscience occupations
TV/VCR

Presentation

A. Introduction

Continued existence is not possible without food. As discussed in previous lessons, about 21 million people in the U.S. are employed in agriscience. About 400,000 people are needed each year to fill positions in this field, yet only 100,000 are currently being filled by trained people. Agriscience professionals provide many of the vital basic commodities. With ever increasing populations around the world, there will always be jobs available in plant science because there will always be a need for food and fiber.

B. Motivation

1. Show a video about careers in plant science.
2. Use a survey to determine students' interests in plant science.
3. Have students read an article about future career opportunities in plant science.
4. Discuss working for a fast food chain vs. a professional career.

C. Assignment
1. Check the classified advertisements in a newspaper for job opportunities in plant science. Research the duties, educational requirements, salary, and opportunity for advancement for a specific advertised job.
2. Select a plant science career for a research paper, using an agricultural occupation textbook, the school library, and university materials as references.
3. Have students list as many plant science occupations as possible.

D. Discussion
1. Question: *What is a career in plant science?*
Answer: A career in plant science is any job that relates in some way to plant science.

2. Question: *What areas of agriscience occupations could include a plant science career?*
Answer:
production agriscience
agriscience processing
horticulture
agriscience sales
renewable natural resources
forestry
Have students give two examples of plant science careers for each of the areas listed above.

E. Other Activities
1. Compile a list of as many agriscience careers as possible and create an educational display.
2. Have a guidance counselor provide the high school requirements for college admission.
3. Have students create a resume.
4. Have students fill out an application for employment.
5. Invite a university official to talk about opportunities for graduates in agriculture/agriscience.

F. Conclusion
Plant science careers can involve most areas of agriscience. Preparation for a career in plant science may involve a degree from a 4-year college, but students can begin by enrolling in agriscience and other academic courses at the middle and high school level.

G. Evaluation
A test, quizzes, or a writing assignment can be used to evaluate the material in this unit.

Duty Area 4 Evaluation
Exploring Plant Science

Name _____

Date _____

1. Match the crop commodity with an example.

____Grain	A.	Broccoli
____Speciality crop	B.	Peanuts
____Tree fruits	C.	Rice
____Citrus	D.	Tomatoes
____Vegetables (cool)	E.	Tobacco
____Sugar crop	F.	Cane
____Oil crop	G.	Lemons
____Vegetables (warm)	H.	Pears

2. Match the plant with the best method of propagation.

____Corn	A.	Division
____Tulips	B.	Layering
____Carrots	C.	Cuttings
____Dogwood	D.	Tissue culture
____Azaleas	E.	Seeding
____African Violets		
____Rhododendrons		

3. The basic types of fertilizer are _____ and _____.

4. _____ is the process by which plants produce their own food.

5. Chlorophyll is the _____ in plants.

6. Plants can be identified by their , _____ flower, _____ , roots, shape, _____, and _____ .

7. The most important chemical process in the atmosphere is the formation of water. T F

8. Carbon dioxide and water combine to make soda. T F

9. Asexual reproduction involves the flower of a plant. T F

10. Tissue culture is known as micropropagation. T F

11. Plants make their own food. T F

12. Which of the following does not have an effect on growing crops?
    A. Pests
    B. Equipment
    C. Humidity
    D. Soil

13. Which of the following is not promoted by nitrogen?
    A. Dark green foliage
    B. Early root formation
    C. Rapid growth
    D. Increased protein

14. Flowering, maturity, early root formation, and winter hardiness are promoted by.
    A. nitrogen
    B. phosphorus
    C. potassium

15. Which of the following is not true of potassium?
    A. Symbol K
    B. Produces strong stems
    C. Converts sugar to energy

16. The leading cause of unhealthy plants is
    A. fertilizer
    B. polluted water
    C. limited sunlight
    D. overwatering

17. All plants require the same amount of water. T F

18. When watering plants, it is best to wet the soil until the water drains from the bottom. T F

19. If a plant is root-bound, its growth is affected. T F

20. When transplanting, dig a hole that is the same size as the root ball. T F

21. Which of the following is a good reason for transplanting plants?
    A. root-bound plant
    B. moving from nursery to yard
    C. both A and B
    D. to place in a prettier pot

22. Mulch helps to prevent moisture loss. T F

23. The science of growing plants without soil is called
    A. Hydrophonics
    B. Aquaculture
    C. Hydroponics
    D. Aquaponics

24. Which of the following is not needed to grow plants hydroponically?
    A. Soluble fertilizer
    B. Soil
    C. Pump
    D. Magnesium sulfate

25. List three types of plants that can be identified.
    A.
    B.
    C.

26. List three ways to plant seeds.
    A.
    B.
    C.

27. What do the numbers 10 - 10- 10 on a bag of fertilizer represent?

28. Give two reasons for using fertilizers.

29. List three reasons why crops are important.

30. Briefly explain how a hydroponics system works.

31. List one advantage of growing plants hydroponically.

32. List one disadvantage of growing plants hydroponically.

33. Name a new technology in plant science, and name at least one way it affects the farmer and the consumer.

34. Using complete sentences, describe a career opportunity dealing with plant science.

Exploring Plant Science
Answer Key

1. C
   E
   H
   G
   A
   F
   B
   D
2. E
   A
   D
   B
   B
   A
   C
3. Granular, soluble
4. Photosynthesis
5. Green
6. Leaves, fruit, seeds, stems
7. F
8. F
9. F
10. T
11. T
12. B
13. B
14. B
15. C
16. D
17. F
18. T
19. T
20. F
21. C
22. F
23. C
24. B
25. Answers will vary.
26. Rows, hills, broadcasting
27. The percent of nitrogen, phosphorus, and potassium in the fertilizer mix.
28. Answers will vary.
29. Food, fiber, and feed for livestock
30. Answers will vary.
31. Answers will vary.
32. Answers will vary.
33. Answers will vary.

Duty Area 5: Overview
Exploring Animal Science

- **Competencies/Tasks**
  - 5.1 Determine the importance of animals to agriculture.
  - 5.2 Explain the importance of animal evaluation.
  - 5.3 Identify key scientific terms used in the animal industry.
  - 5.4 Explore the meat animal industry.
  - 5.5 Explore the pleasure and companion animal industry.
  - 5.6 Discuss new technologies in animal science.
  - 5.7 Discuss ethical concerns related to animal welfare.
  - 5.8 Explore career opportunities in animal science.

- **Lessons**
  - 5.1 The Importance of Animals to Agriculture
  - 5.2 The Importance of Animal Evaluation
  - 5.3 Scientific Terms Used in the Animal Industry
  - 5.4 Exploring the Meat Animal Industry
  - 5.5 Pleasure and Companion Animal Industry
  - 5.6 New Technologies in Animal Science
  - 5.7 Ethical Concerns Related to Animal Welfare
  - 5.8 Career Opportunities in Animal Science

- **Evaluation**

  Suggestions for evaluation appear at the end of each lesson.

DUTY AREA 5
Exploring Animal Science

Lesson 5.1 The Importance of Animals to Agriculture

Student Objectives

1. Define animal science.
2. Identify major uses of animals.
3. Identify products provided by animals.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications*. Albany, NY: Delmar Publishers, Inc., 1990.

Gillispie, James R. *Modern Livestock and Poultry Production*. Albany, NY: Delmar Publishers, Inc., 1992.

Griffin, Margaret and Deborah Seed. *The Amazing Egg Book*. Reading, MS: Addison-Wesley Publishing, Co, Inc., 1989.

Herren, Ray. *The Science of Animal Agriculture*. Albany, NY: Delmar Publishers, 1994.

Krebs, Alfred H. and Michael E. Newman. *Agriscience In Our Lives*. 6th ed. Danville, IL: Interstate Publishers, Inc., 1994.

Ross, Catherine and Susan Wallace. *The Amazing Milk Book*. Reading, MS: Addison-Wesley Publishing, Co, Inc., 1991.

Equipment, Supplies, Materials

at least 20 animal products (candles, candy, cosmetics, leather shoes, heart valves, etc.)

Presentation

A. Introduction

Animals meet important needs in our daily lives. They provide us with food, clothing, companionship, recreation, and income. They are used in research and education. This lesson explores the role of animals in agriculture and in society.

B. Motivation

Have students bring in a variety of animal products, then hold a contest to see which student can correctly name the source of each product.

C. Assignment
Have students design a chart to illustrate the products of a specific animal species.

D. Discussion

1. *Question: What is the definition of animal science?*
Answer: It is the study of animals and all that relates to animals.
Allow students to develop a definition that they understand before providing them with a definition.

2. *Question: How are animals important to agriculture?*
Answer: Animals are important to agriculture in the following ways:
   - Sources of clothing: animal skins, hair, and furs
   - Sources of power: as a means of transportation and a means of pulling heavy loads
   - Sources of food: grasses and other fiber feeds eaten by animals are then passed along to meat-eating humans
   - Sources of by-products: products other than meat that come from an animal carcass such as the hide, hair, etc.
   - Sources of recreation: pleasure and companionship
   - Sources of money: income for the person who raises animals for products such milk, wool, eggs, or the animal itself

3. *Question: What are some products provided by animals?*
Answer:

Cows/Bulls
meat: steaks, hamburger, roasts
leather: belts, coats, shoes
animal fats: cosmetics, marshmallows
medicines: insulin, thyroid extract
dairy cattle: cheese, ice cream, cottage cheese, butter

Pigs
meat: bacon, ham, pork chops
medicines: insulin, replacement heart valves
fats: crayons, candles

Sheep
meat: tripe, lamb chops
wool: coats, sweaters, lanolin hand lotion
medicine: adrenalin

Poultry
eggs
feathers: pillow stuffings, jacket insulation
meat
game birds: quail, pheasant

Horses
pleasure
glue

Fish
- animal feed
- meat
- sport

Rabbits
- meat
- fur: coats, hats, gloves, toys

Medical research
- cosmetics testing

Llamas
- hair: rope, crafts
- work: carry packs

Ostriches
- meat
- leather
- feathers

Laboratory Animals
- medical research

Honeybees
- pollination
- honey

Many by-products can come from more than one species of animal. This list is not comprehensive.

E. Other Activities
1. Have students participate in the Middle School Food and Fiber Contest at the local, state, or federal level.
2. Have students prepare a product derived from an animal, such as ice cream or yogurt.
3. Work with other school departments to allow students to expand their animal product study.
   - Agriculture: Have students describe how milk is produced.
   - Home economics: Have students prepare a food with milk as main ingredient.
   - Technology: Have students explain the use of electric milkers.
   - Art: Have students make "milk prints," substituting milk for ink.

F. Conclusion
Animals play an important role in agriculture. The following lessons will look more closely at the roles of animals.

G. Evaluation
Have students match 20 products with their animal origin.

Lesson 5.2 The Importance of Animal Evaluation

Student Objectives

1. Discuss the importance of animal evaluation.
2. Identify the main ways to evaluate animals.
3. Determine selection differences for market and breeding animals.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications.* Albany, NY: Delmar Publishers, Inc., 1990.

Ensminger, M. E. *Animal Science Digest.* Danville, IL: Interstate Printers, Inc., 1991.

Gillispie, James R. *Modern Livestock and Poultry Production.* Albany, NY: Delmar Publishers, Inc., 1992.

Herren, Ray. *The Science of Animal Agriculture.* Albany, NY: Delmar Publishers, Inc., 1994.

Presentation

A. Introduction

Animal evaluation involves more than placing a class of four animals from best to worst. It involves making decisions about the quality of an animal based upon scientific knowledge. Many in the industry use evaluation to continually improve their herds. This lesson examines the importance of animal evaluation.

B. Motivation

1. Take students on a field trip to a performance testing station.
2. Have students talk about their experiences of showing animals at the county or state fair.
3. Using pictures, have students compare the ideal animal of 10 to 20 years ago with today's ideal animal. Have class discussion about the changes and how they were achieved.

C. Discussion

1. *Question: Why is animal evaluation important?*
   Answer: Animal evaluation is used to continually improve the animal industry. Through selection of certain traits and characteristics, animals have evolved to the typical type of animal found in the industry today.

2. *Question: What are the two main functions of animal selection?*
   Answer: The two main functions of animal selection are to improve the quality of the offspring and to provide better quality animal products.

3. *Question: What qualities are sought when selecting animals?*
   Answers:
   - Reproduction ability: the ability to continually produce an offspring

- Growth capabilities: the ability of the animal to grow rapidly
- Efficiency: growing rapidly without wasting feed or other necessities

4. *Question: How are animals evaluated?*
   Answer:
   - Pedigree: Look at performance of ancestors to help determine its performance.
   - Production testing: Look at evaluation of the animal based upon its own records. Each species of animal has various criteria that must be met.
   - Type and individuality: Look at selection based on the ideal animal (also called conformation).

   Choose several species of animals and discuss selection methods, if time permits.

5. *Question: How is selection different for market animals and breeding animals?*
   Answer: When selecting market animals a person looks at how well the animal can convert food to muscle. Animals that are too fat will not produce quality meat. Breeding animals are used to reproduce and improve the herd. Traits selected for breeding are ones that will produce a better offspring.

D. Other Activities
   1. Provide students an opportunity to participate on an animal evaluation team.
   2. Provide students an opportunity to participate in the Block and Bridle Livestock and Stockmans Contest at Virginia Tech.

E. Conclusion
   As the demand for better performing animals grows, methods of selection increase and improve. Our ancestors mainly used visual appearance for selection. Technology has allowed us to go beyond that and use scientific methods. Future lessons will explore some of these new technologies.

F. Evaluation
   Use the test provided at the end of the duty area.

Lesson 5.3 Scientific Terms Used in the Animal Industry

Student Objectives

Define scientific terms used in the animal industry.

References

Burton, L. DeVere. *Agriscience and Technology.* Albany, NY: Delmar Publishers, Inc., 1992.
Cooper, Elmer L. *Agriscience: Fundamentals and Applications.* Albany, NY: Delmar Publishers, Inc., 1990.
Herren, Ray and Roy Donahue. *The Agriculture Dictionary.* Albany, NY: Delmar Publishers, Inc., 1991.
Herren, Ray. *The Science of Animal Agriculture.* Albany, NY: Delmar Publishers, Inc., 1994.

Equipment, Supplies, Materials

animal related magazines, literature, research articles, news articles
dictionaries for each student in the class

Presentation

A. Introduction
To better understand new trends in the animal industry, this lesson examines scientific terms that are related to the animal industry.

B. Motivation
Have students read articles related to the animal science industry. Include articles about bees, rabbits, game birds, and other nontraditional farm animals. Have students list unfamiliar words to define.

C. Assignment
Have students work in groups of four to write definitions (in words they can understand), and study the words.

D. Discussion
1. *Question: What are key scientific terms in the animal industry?*
Answers: **Aerobic organisms**
grow in the presence of oxygen
Anaerobic organisms
grow without the presence of oxygen
Alternative animal agriculture
production of nontraditional farm animals
might include rabbits, fish, game birds, and bees
Animal science technology
using modern practices and principles in the animal industry

Aquaculture
production of animals that live in water
Artificial insemination
breeding animals other than by natural mating
Biotechnology
using technology to control traits passed on from parent to offspring
Clone
An exact duplicate of the parent
Confinement operation
system of raising animals in a relatively small space
Control group
group of animals in an experiment that does not receive treatment
Crossbreeding
animals with parents of two different breeds
Embryo
an animal in its first stage of growth
Embryo transfer
removing an embryo from one female and placing it in another female
Estrus synchronization
using synthetic hormones to make a group of females come into heat at the same time
Feed conversion ratio
the rate at which an animal converts feed to meat
Fry
a small, newly hatched fish
Gene
a single unit containing hereditary material
Genetic engineering
changing hereditary traits by altering genes.
Grease wool
wool directly from the sheep
Hive
structure used to house bees
Hybrid
an animal produced from the mating of parents of different breeds
Implant
a substance placed under the skin of animals to help them grow
Incubation
process of providing fertilized eggs with the right amount of heat, humidity, and time to hatch
Lactation
milk production
Pedigree
a record of an animal's ancestors
Progeny
the offspring of an animal

Progeny testing
system used to determine the value of an animal based on the offsprings' performances
Selective breeding
selection of parents in order to get better offspring
Spawning
process used by fish for laying eggs
Superovulation
injecting hormones to cause a higher than usual number of ovulations during the heat period
Vacuum packaging
packaging meat in plastic and then removing the air

This list is only a partial compilation of scientific terms. Terms are to be used at the teacher's discretion.

E. Other Activities
1. Play animal science jeopardy with the terms.
2. Work with the science and English teachers to increase exposure to the words.
3. Have students derive a list of words from agricultural magazines to use for defining.

F. Conclusion
Knowledge of key scientific terms examined in this lesson will facilitate a better understanding of animal industry technologies.

H. Evaluation
Develop a vocabulary test for selected words.

Lesson 5.4 Exploring the Meat Animal Industry

Student Objectives

1. Discuss the importance of the meat animal industry.
2. Explain the process used to get meat from the farm to the table.
3. Identify meat sources.

References

Ensminger, M. E. *Animal Science Digest.* Danville, IL: Interstate Publishers, Inc., 1991.

Gillispie, James R. *Modern Livestock and Poultry Production.* Albany, NY: Delmar Publishers, Inc., 1992.

Herren, Ray. *The Science of Animal Agriculture.* Albany, NY: Delmar Publishers, Inc.,1994.

Krebs, Alfred H. and Michael E. Newman. *Agriscience In Our Lives.* 6th ed. Danville, IL: Interstate Publishers, Inc., 1994.

Packer to Consumer (Video). Winterville, GA: American Association for Vocational Instructional Materials.

Va. Department of Agricultural and Consumer Services. *Facts About... Virginia's Agriculture.* Richmond, VA: Virginia Agricultural Statistics.

Va. Department of Agricultural and Consumer Services. *Virginia Agricultural Statistics.* Richmond, VA: Virginia Agricultural Statistics, latest edition.

Equipment, Supplies, Materials

TV/VCR

Presentation

A. Introduction

The lesson entitled, "The Importance of Animals to Agriculture," explained that animals provide people with many products. The most well known product is meat. This lesson explores the meat animal industry.

B. Motivation

1. Take students on a tour of a local slaughter house, meat processing plant, or meat department of a grocery store.
2. View video *Packer to Consumer.*

C. Discussion

1. *Question: What is the main purpose of the meat animal industry?*
   Answer: The main purpose of the meat animal industry is to raise quality animals in order to provide humans with essential nutrients for a good diet.

2. *Question: What animals are considered meat animals?*
   Answers: beef cattle
   sheep

hogs
poultry
fish
game animals: rabbits, doves, etc.

3. *Question: Why is the meat industry important?*
   Answer: Americans are meat eaters. An average person can eat 97 pounds of beef, 64 pounds of pork, and 90 pounds of poultry in a year. This does not include the 12 percent of seafood and 10 to 12 million pounds of rabbit meat eaten each year by Americans. The United States consumes 11.4 percent of the total world production of meat.

4. *Question: How is the meat industry important to Virginia?*
   Answer: Virginia ranks among the top 25 states in this country in meat production. In 1991, Virginia produced over 840 thousand pounds of red meat. In addition, the poultry industry ranks among the top 10 states based on production. Commercial broiler production provided over 980 thousand pounds of meat in 1991. Turkey pounds equaled over 320 thousand pounds. It is not uncommon to find many of Virginia's meat products being served in restaurants.

5. *Question: What are the steps in getting meat from the farm to the table?*
   Answer:
   producing
   transporting
   processing
   packaging
   distributing
   marketing

D. Other Activities
   Have students prepare an ad campaign to sell a meat product. Discourage students from using slogans already developed such as "Beef–Real Food for Real People" or "Pork, the Other White Meat." Encourage students to be creative using any available resources.

E. Conclusion
   The meat animal industry not only provides people with food, but it is of major importance to the community's, state's, and nation's economy.

F. Evaluation
   Use unit evaluation provided at the end of the duty area.

Lesson 5.5 Pleasure and Companion Animal Industry

Student Objectives

1. Define a pleasure and companion animal.
2. Identify species of pleasure and companion animals.
3. Identify basic practices for care of pleasure and companion animals.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications.* Albany, NY: Delmar Publishers, Inc., 1990.

Ensminger, M. E. *Animal Science Digest.* Danville, IL: Interstate Publishers, Inc., 1991.

Responsible Pet Ownership (Video). American Veterinary Medical Association. Available from Modern Talking Pictures.

Selected topic books from the school or local library

Presentation

A. Introduction

Not all animals in agriculture are used for meat or animal products. There are many animals in the industry that are used to provide companionship or pleasure. This lesson focuses on these animals.

B. Motivation

1. Have students talk about their pets and what purpose they serve.
2. Invite a pet store owner to come in and talk about animal care.
3. Tour the local SPCA and talk with an official about responsible pet ownership.

C. Assignment

1. Have students identify equipment used to raise and maintain the animals discussed in class.
2. Have students identify at least three common breeds of animal species discussed in class.

D. Discussion

1. *Question: What are companion or pleasure animals?*
   Answer: They serve as companions and friends, and bring pleasure to people. Companion animals have been proven to increase the life expectancy of elderly people.

2. *Question: What are some examples of pleasure and companion animals?*
   Answers: horses
   dogs
   cats
   rabbits
   fish

birds
hamsters

Students may have other examples such as snakes, ferrets, gerbils, guinea pigs, ducks, or spiders.

3. *Question: How are companion and pleasure animals used?*
   Answer: pets
   hunting
   showing
   riding

   Students may have other uses to list.

4. *What are some basic practices to follow for the care of a companion or pleasure animal?*
   Answer: **Horses**
   Groom daily.
   Keep water out of the horse's ears and dry quickly after a bath.
   Inspect and clean hooves daily.
   Cool horse thoroughly after riding or workouts.
   Do not overfeed.
   Feed on a regular schedule.
   Never use moldy feed.
   Always provide plenty of clean water.
   Follow a strict health program.
   Keep stall clean.

   Dogs
   Groom daily.
   Exercise.
   Feed daily (set amount or free amount).
   Always provide plenty of clean water.
   Vaccinate for rabies.
   Immunize against disease.

   Cats
   Feed twice a day. (Start kittens with four meals per day and then cut back to two.)
   Keep litter box (indoor cats).
   Groom as needed.
   Exercise.
   Provide scratching post (indoor cats).
   Vaccinate for rabies.
   Immunize against diseases.
   Always provide plenty of clean water.

Suggested Activity: Bring in a horse, dog and/or cat (well-behaved), and demonstrate basic care and health checks.

Rabbits
Provide a hutch and clean daily (outdoor rabbit).
Provide cage and litter box (indoor rabbit).
Feed special dry rabbit food, hay, grass, and fresh vegetables.
Feed dry food twice daily.

Supply clean, fresh water.
Provide a small log to chew (helps keep teeth ground down).
Brush every day.
Provide a friend for your rabbit (another rabbit, or a small bird).
Keep dogs and cats away.
Check coat, eyes, ears, teeth, and toenails daily for signs of illness.
Immunize against diseases.

Suggested Activity: Set up a rabbit hutch in the department. Have several females on hand for the students to learn basic animal care.

Fish

Select an appropriate tank (glass or plastic).
Provide large enough tank (size is determined by number and size of fish to be housed).
Provide quality water (correct amount of dissolved oxygen, water hardness, acidity, and nitrate level).
Provide proper water temperature for tropical fish (73° to 79°F).
Provide optimal lighting.
Feed small amounts once to twice daily.
Clean tank on a regular basis.
Maintain a health watch, looking for fungus, white spot, etc.
Handle correctly to prevent injury.

Work with the science program in setting up a fish aquarium in the department.

Birds

Provide a roomy and sturdy home (Rule of thumb: Birds should be able to stretch out their wings without touching the sides; heads should not touch the cage top; nor tail feather touch the sides or floor when perched.)
Place cages away from drafts and odors.
Keep birds on a routine (water, feed, and clean cage at same time daily).
Always have clean water for drinking and bathing.
Provide a varied and well-balanced diet (pellet, grains, fresh vegetables, fruits, meat, and dairy products).
Trim nails, beak, and wings when needed.
Provide exercise.
Follow a health plan to prevent parasites, diseases, and injuries.

Suggested Activity: Invite a pet store owner in to talk about bird selection and care.

Hamsters

Provide a large metal cage to allow for exercise.
Use light fluffy material for bedding (cedar shavings).
Feed mixture of seeds and vegetables.
Feed only to replenish supply (hamsters hoard their food).
Supply clean, fresh water.
Keep animals away from human diseases (colds, pneumonia, and bacterial infections).
Provide vitamin supplement.

Suggested Activity: Set up a hamster cage in the department. Provide students with responsibility of the animal's care.

Discussion of other animals can be substituted for animals mentioned above. The discussion was focused on care of the animals as pets. Other areas to talk about include raising animals to sell and showing animals in competition.

E. Other Activities
1. Have students participate in the Middle School FFA Companion/Small Animal Contest.
2. Take students on a tour of a pet store.
3. Have students enter an animal in a local show or fair.
4. Work with other departments in the school to identify the historical, literary, and scientific background of the animals.

F. Conclusion
Animals kept in captivity (cats, dogs, horses, snakes, or tarantula spiders), depend on humans to take care of them. Taking the necessary steps to provide the animal with a healthy life will bring much enjoyment to the companion or pleasure animal and its owner.

H. Evaluation
Test questions are provided at the end of the unit.

Lesson 5.6 New Technologies in Animal Science

Student Objectives

1. Identify new trends in reproduction.
2. Identify new trends in management.
3. Identify new methods for processing products.
4. Identify new techniques used to market products.

References

Burton, L. DeVere. *Agriscience and Technology.* Albany, NY: Delmar Publishers Inc., 1992.

U.S. Department of Agriculture. *New Crops, New Uses, New Markets: 1992 Yearbook of Agriculture.* Washington, DC: U.S. Government Printing Office.

Equipment, Supplies, Materials

magazines
newspapers
research articles and journals

Presentation

A. Introduction

New discoveries are being made all the time in the animal science industry. They involve news trends in reproduction and management and new methods of processing and marketing products. This lesson explores these new technologies.

B. Motivation

Have students find articles concerning new developments in animal science. Provide resources in the classroom for students who do not have access to other sources.

C. Assignment

Have students bring in articles about new developments in animal science.

D. Discussion

1. *Question: What are some new trends in the field of reproduction?*
   Answers: artificial insemination
   estrus synchronization
   embryo transfer
   gene splicing
   cloning

2. *Question: What changes are being made in the area of animal management?*
   Answers: electronic sensors
   robots
   recycled animal wastes
   electrical timing devices

3. *Question: How has the processing of animal products changed?*
   Answers: use of computers
   robotics
   laser technology
   quality control
   modern equipment
   extended shelf life
   preservation
   packaging

4. *Question: What new technologies have been developed in marketing animal products?*
   Answers: Agriculturists have developed new and quicker ways to market their products. Some examples include:
   video merchandising
   telemarketing
   futures trading
   advertising.

E. Other Activities
   1. Invite a guest speaker from the animal industry to provide a program on a new technology that he/she is using.
   2. Arrange a tour of a local animal industry to see new technologies in use.

F. Conclusion
   New technologies are being developed in the animal industry constantly. Scientists are developing better ways to produce outstanding animals. As a result, the products which consumers use are of higher quality, yet still affordable.

H. Evaluation
   A test is provided at the end of the unit.

Lesson 5.7 Ethical Concerns Related to Animal Welfare

Student Objectives

1. Identify laws passed to govern animal usage.
2. Discuss the major issues concerning animal welfare.

References

Animal Agriculture: Myths and Facts. Arlington, VA: Animal Industry Foundation, 1989.
Animal Welfare (Video). May be purchased from Hobar Publications, St. Paul, MN.
Gillispie, James R. *Modern Livestock and Poultry Production.* Albany, NY: Delmar Publishers, Inc., 1992.
Herren, Ray. *The Science of Animal Agriculture.* Albany, NY: Delmar Publishers, Inc., 1994.

Equipment, Supplies, Materials

TV/VCR

Presentation

A. Introduction

This lesson on animal welfare is designed to provide information concerning the issues of animal rights. This lesson discusses the welfare of farm animals and pets.

B. Motivation

1. Show the students the video tape *Animal Welfare.*
2. Invite a representative from the local SPCA, local farm organization, and/or a veterinarian to come in and discuss animal welfare issues.

C. Discussion

1. *Question: What is animal welfare?*
   Answer: Animal welfare involves taking care of animals to make sure they stay healthy, happy, and fit.

2. *Question: Why is animal welfare such an important issue?*
   Answer: Since the beginning of time, animals have been important to humans. Animals have provided food, clothing, shelter, jewelry, and companionship. As animals have become domesticated, people have become interested in the rights of animals.

3. *Question: What are two types of activists and what are their beliefs?*
   Answer: An activist is a person who strongly promotes or supports an idea or concept.
   - Animal rights activists: This group of people believes that animals should have the same rights as humans. They do not think animals should be used or killed for human gain.
   - Animal welfare activists: This group believes animals should be used by humans, but they should not be abused or mistreated. They promote animals being kept happy and comfortable while they are alive.

   For further exploration, have students identify various animal welfare groups such as ALF, PETA, and the SPCA.

4. *Question: What laws have been passed to regulate animal usage?*
   Answer: Several laws have been passed over the years in support of animal well-being.
   - *Body of Liberties Code of 1641*: This was the first anti-cruelty law to be passed. The code was passed by the Massachusetts Bay Colony. It includes a section to prevent cruelty to animals that are being moved from place to place.
   - *Humane Slaughter Act of 1958*: This law prevents cruel and inhumane treatment to animals being slaughtered.
   - *Animal Welfare Act of 1970*: This law was passed to include humane treatment of cats, dogs, and laboratory animals.

5. *Question: What areas of agriculture concern animal activists?*
   Answers: confinement operations
   use of drugs
   management practices
   research

6. *Question: In what ways do each of these areas raise concerns?*
   Answer: **Confinement operations**
   - Activist sees farms as animal factories, and disapproves of animals raised in cages, pens, or crates.
   - Agriculturist believes confinement cages, crates, etc., are necessary for safety and well being of animals. For example, farrowing crates are necessary to keep sows from mashing their pigs.

   Use of drugs
   - Activist is afraid that drugs used in animal feeds will show up in the meat consumed by humans and also suggests that bacteria in animals will develop immunity to the drugs and cause a health hazard.
   - Agriculturist feels that a healthy animal is better for all concerned. Animals free of disease and parasites are healthy and suffer less.

   Management practices
   - Activist wants to prevent castrating, docking of sheep's tails, debeaking of chickens, and dehorning and branding of cattle. They feel that these procedures are cruel.

- Agriculturist sees these as necessary practices for an animal's well being. Castrating is necessary to prevent males from fighting with each other. Docking is done to keep sheep cleaner. Debeaking of chickens and dehorning of cattle is performed to prevent injury to each other. All of these practices are performed at an early age and with the most modern techniques to reduce stress.

Research

- Activist argues that animals, especially cats and dogs, should not be used in medical research, nor should animals be used to test cosmetics.
- Agriculturist believe that medical research using animals is necessary because cell cultures and computer simulations are not as lifelike. Many great medical discoveries have been developed through animal research, such as the elimination of polio.

These are some important ideas for further discussion. A panel discussion or debate can be used to expand the knowledge base.

7. *Question: What are some local laws regulating animal handling?*
   Answer: Answers in this section will depend on county, town, or city ordinances. Areas of possible discussion will include leash laws, disease control, noise ordinances, vaccination programs, animal abuse ordinances, and tags.

D. Other Activities
   1. Debate an animal welfare issue.
   2. Use animal welfare issues as a speech topic for a public speaking contest.
   3. Access the legislative network on VA PEN. Search for any new laws in Virginia that may affect animals.

E. Conclusion
   Animals are an important part of agriculture, therefore griculturalists must be concerned about animal issues, uses, and welfare.

F. Evaluation
   A test is provided at the end of the unit.

Lesson 5.8 Career Opportunities in Animal Science

Student Objectives

1. Identify a career in each area of the animal science industry.
2. Discuss educational requirements for particular careers.

References

Dictionary of Occupational Titles. Available from guidance department of local school.

Gillispie, James R. *Modern Livestock and Poultry Production.* Albany, NY: Delmar Publishers, Inc., 1992.

Herren, Ray. *The Science of Animal Agriculture.* Albany, NY: Delmar Publishers, Inc., 1994.

Presentation

A. Introduction

Opportunities abound in animal science. They range from producing livestock to gene splicing. This lesson looks at a wide variety of animal science careers.

B. Motivation

Distribute copies of the *Yellow Pages*. Award a prize to the student who can find the most businesses related to animal science.

C. Assignment

Have students develop a theme poster, display, or bulletin board with careers in animal science as the central focus.

D. Discussion

1. *Question: What level of education is required for a career in animal science?*
   Answer: Education requirements in animal science range from having a high school diploma to a Ph.D. in the animal science field.

2. *Question: What careers are available with a high school diploma?*
   Note: Jobs listed below for questions 2-5 suggest minimum level of education needed to be successful. This list is not exclusive; refer to the *Dictionary of Occupational Titles* for other examples.

   Answer:
   sheep shearer
   small animal producer
   small animal caretaker
   herdsman
   farmer
   meat cutter

3. *Question: What careers are available for a person with an associate degree?*
   Answers: wool grader
   veterinarian assistant
   animal buyer
   embryo implant technician
   farm loan officer
4. *Question: What careers are available for a person with a bachelor's degree?*
   Answers:
   agriculture teacher
   extension agent
   meat grader
   agricultural journalist
   marketing analyst

5. *Question: What careers are available for a person with a graduate degree?*
   Answers:
   veterinarian
   meat inspector
   microbiologist
   college professor
   animal geneticist

6. *Question: Where in Virginia can a person gain the necessary educational requirements for work in the animal sciences?*
   Answer: A good place to start is with the local agricultural education program. After high school, local community colleges offer various programs related to animal sciences. Two four-year universities, Virginia Tech and Virginia State, offer programs in the animal sciences for the bachelors, masters and doctoral degrees. Virginia Tech also offers an animal agriculture option for persons interested in a two-year program. The Virginia-Maryland Regional College of Veterinary Medicine offers course work towards the degree of DVM.

E. Other Activities
   1. Sponsor a career day. Invite representatives to talk about career opportunities available in the animal sciences.
   2. Take students on a tour of an animal science-related industry, college program, or local farm to find out more about opportunities.

G. Conclusion
   Many different groups of people can provide information about careers in animal science. The local agricultural education program offers many activities in the animal sciences.

H. Evaluation
   Students may be evaluated on the exercise presented in the assignment section.

Duty Area 5 Evaluation
Exploring Animal Science

Name_____
Date_____

I. TRUE OR FALSE: Circle the correct letter.

T F 1. The study of animals is called animal science.

T F 2. Animals are no longer used as work sources in the world.

T F 3. Animals not only provide us with meat but with useful by-products as well.

T F 4. Cosmetics are a by-product of animal bone.

T F 5. Animals are a good source for providing insulin to diabetics.

T F 6. Many people fight against the agriculture industry because animals are used and sometimes killed for medical research.

T F 7. An animal's pedigree can help a producer predict how well the animal will perform.

T F 8. A fry is a newly hatched chicken.

T F 9. Grease wool is wool that produces a lot of grease.

T F 10. The following are considered meat animals: dairy cattle, sheep, chickens, and rabbits.

T F 11. Robotic arms are used to milk cows.

T F 12. Technology allows for a computer chip to tell a machine how much feed to give a cow.

T F 13. The way animal products are marketed has not changed over the years.

T F 14. Animal rights activists believe that it is all right for animals to be used by humans.

T F 15. Careers in the animal industry are limited.

II. FILL IN THE BLANK:

16. Dairy cattle provide us with _____ and _____.

17. Cosmetics and _____ are products of animal fats.

18. Rabbit fur can be used for _____, _____, and _____.

19. Animals have to have the ability to _____ to provide us with quality offspring.

20. Meat producing animals convert _____ to _____.

21. Examples of alternative animals are _____, _____, and _____.

22. Organisms that grow in the presence of _____ are called aerobic.

23. The ability to control animal traits from one generation to the next is called _____.

24. An average American can eat _____ of beef and 90 pounds of poultry in a year.

25. The last step in getting meat from the farm to the consumer is _____.

III. SHORT ANSWER:

26. Briefly summarize the importance of Virginia's meat industry.

27. List four examples of pleasure animals.

28. Select a pleasure animal and list the basic practices necessary for the animal's care.

29. Select a new technology in the animal industry and discuss its importance. Include such things as benefits and increased products.

30. Identify some of the local laws in your community that concern animal handling.

Exploring Animal Science
Answer Key

1. T
2. F
3. T
4. F
5. T
6. T
7. T
8. F
9. F
10. F
11. T
12. T
13. F
14. F
15. F
16. Milk, dairy products
17. Marshmallows
18. Coats, toys, hats
19. Reproduce
20. Grasses, meat
21. Rabbits, fish, bees (Answers will vary.)
22. Oxygen
23. Biotechnology
24. 92 pounds
25. Marketing
26. Answers will vary.
27. Answers will vary.
28. Answers will vary.
29. Answers will vary.
30. Answers will vary.

DUTY AREA 6: OVERVIEW
Introducing Basic Laboratory Skills

- **Competencies/Tasks**
  - 6.1 Apply safety practices.
  - 6.2 Identify types of metal.
  - 6.3 Perform metal fabrication practices.
  - 6.4 Read and interpret simple plans.
  - 6.5 Identify and use basic hand tools for woodworking.
  - 6.6 Maintain hand tools.
  - 6.7 Select and use measuring devices.
  - 6.8 Select and use wood fasteners.
  - 6.9 Finish and preserve wood.

- **Lessons**
  - 6.1 The Importance of Safety Practices
  - 6.2 Identifying Metal Types
  - 6.3 Performing Metal Fabrication Practices
  - 6.4 Reading and Interpreting Simple Plans
  - 6.5 Identifying and Using Basic Hand Tools for Woodworking
  - 6.6 Maintaining Hand Tools
  - 6.7 Selection and Use of Measuring Tools
  - 6.8 Selecting and Using Wood Fasteners
  - 6.9 Finishing and Preserving Wood

- **Evaluation**

  Suggestions for evaluation appear at the end of each lesson.

DUTY AREA 6
Introducing Basic Laboratory Skills

Lesson 6.1 The Importance of Safety Practices

Student Objectives

1. Identify basic laboratory safety practices.
2. Practice basic laboratory safety.
3. Complete a safety test with a score of 100 %.

Reference

Burke, Stanley R. and T. J. Wakeman. *Modern Agricultural Mechanics*. 2nd ed. Danville, IL: Interstate Publishers, Inc., 1991.

Cooper, Elmer L. *Agricultural Mechanics: Fundamentals and Applications*. 2nd ed. Albany, NY: Delmar Publishers, Inc., 1987.

Hand Tool Safety (Video). Available from Hobar Publications. St. Paul, MN.

Introduction to Woodshop/Carpentry Safety (Video). Available from Hobar Publications. St. Paul, MN.

Equipment, Supplies, Materials

video tapes
TV/VCR

Presentation

A. Introduction

Most accidents occur as a result of carelessness. When working in the laboratory setting students must pay attention to their work to avoid injury. This lesson discusses basic safety practices necessary to work with various materials.

B. Motivation

Show slide presentation on basic laboratory safety.

C. Discussion

1. *Question: Why are safety procedures developed?*

   Answer: Safety procedures are developed to provide guidelines for safe work habits. When procedures are not followed, serious injury can occur. The following rules will help prevent accidents:

   - Wear safety glasses; it is a state law.
   - Wear protective clothing.

- Keep the laboratory clean.
- Avoid horseplay at all times.
- Do not throw objects.
- Store tools properly.
- Do not use tools without permission.
- Use the correct tool.
- Report broken tools to the instructor.
- Pay attention to your work at all times.
- Leave guards and shields in place.
- Grip tools firmly.
- Keep cutting tools sharp.
- Keep tools clean.

2. *Question: What type of safety procedures should be followed when working with metal?*
   Answer: In addition to the general safety rules discussed earlier, the following rules apply:
   - Work in a well ventilated area.
   - Never touch hot metal.
   - Wear gloves when handling metal with sharp edges.
   - Wear special eye protection when welding.
   - Wear a leather apron and flame retardant clothing.

   This list only reflects general metal working safety procedures. Other procedures will be determined by the type of work being done.

3. *Question: What are some safety procedures specific to woodworking?*
   Answer:
   - Properly secure all work.
   - Use both hands when working with power tools.
   - Wear a face shield.
   - Handle sharp and pointed tools with caution.
   - Equip files and rasps with handles.

D. Other Activities
Conduct a safety scavenger hunt. Stage safe and unsafe practices; let students troubleshoot.

E. Conclusion
Laboratory safety is a serious issue. When directions are not followed, and attention is not on work, accidents can happen. Precautions must be taken to reduce accidents.

F. Evaluation
Test students on their safety knowledge. A sample test is provided at the end of this unit. (7VA 6.1)

Lesson 6.2 Identifying Metal Types

Student Objective

1. Identify different metal types.
2. Discuss properties of selected metals.
3. Define terms related to metals.

Reference

Burke, Stanley R. and T. J. Wakeman. *Modern Agricultural Mechanics*. 2nd ed. Danville, IL: Interstate Publishers, Inc., 1991.

Cooper, Elmer L. Agricultural Mechanics: *Fundamentals and Applications*. 2nd ed. Albany, NY: Delmar Publishers, Inc., 1987.

Heimler, Charles H. and Jack Price. *Focus on Physical Science*. Columbus, OH: Merrill Publishing Company.

Equipment Supplies, Materials

samples of various metals and alloys (See discussion section for list.)
magnets
vinegar
cold chisels and hammers

Presentation

A. Introduction

Without metals, many of the things people use would not be available, such as watches, jewelry, or the option to take a bus to work or school. Many items that are used daily have some type of metal composition. This lesson examines ways to identify metals in order to use them more effectively.

B. Motivation

1. Using the grinder, conduct a spark test on various types of metal. (For safety reasons, only the instructor should perform this operation.) Have students note the different types of sparks produced.
2. Conduct an acetic acid (vinegar) test on aluminum and magnesium. Discuss with students why the magnesium causes the vinegar to fizz and the aluminum has no reaction.

C. Discussion

1. *What is metal?*

Answer: Metal is an element. Combined with one or more other elements, it produces an alloy. Metals conduct heat and electrical current. They also can be rolled or beaten into sheets, and pulled into wires.

2. Question: *Why are metals important in agriculture?*
   Answer: The basic uses of metals in agriculture involve farm machinery, tools, and construction. However, agriculture uses metal for more than construction and farm equipment. Uses can include conduction of electricity and heat; nutrients for plants; medicines for human health; and forming alloys to make many more products.
   Suggested Activity: If possible bring in samples of metals and discuss their uses.

3. Question: *What are the main properties used to identify metals?*
   Answer: Metals are identified by various characteristics that include their mechanical, chemical, physical, thermal, optical, electromagnetic, and acoustical properties.

   Mechanical properties:
   - hardness
   - brittleness
   - ductile ability
   - wear
   - strength

   Chemical properties:
   - oxide or compound composition
   - acidity or alkalinity
   - corrosion resistance

   Physical properties:
   - shape
   - weight

   Thermal properties:
   - expansion and contraction
   - melting point

   Optical properties:
   - color
   - light reflection

   Electromagnetic properties:
   - electrical properties
   - magnetic properties

   Acoustical properties:
   - transmit sound
   - reflect sound

   Suggested Activity: This list highlights all the main characteristics of metals. Work with the science teacher to set up experiments based on the above properties. Use metals that are commonly used in agriculture.

4. Question: *What are some of the more common metals and alloys used in agriculture?*
   Answer:
   - aluminum
   - brass
   - bronze
   - cast iron
   - copper
   - galvanized steel
   - lead
   - mild steel

stainless steel
tin
tool steel
wrought iron

Use transparency master 7VA 6.2 for chart of description and uses.

D. Other Activities

Select a set of unknown metals. Using the characteristics list for identifying metals, have students perform the visual appearance test, the magnetic test, the corrosion test, and the hardness test.

E. Conclusion

By learning how to identify metals, an individual can then determine the uses and capabilities of a particular metal. This information can be very important when using metals in construction and manufacturing.

H. Evaluation

Evaluate students on their ability to determine the type of metal for a given unknown. (The science teacher may be able to provide samples.)

Lesson 6.3 Performing Metal Fabrication Practices

Student Objective

1. Work with metal safely.
2. Clean and prepare metal for work.
3. Interpret a simple plan to construct a project.
4. Measure and cut metal.

Reference

Burke, Stanley R. and T. J. Wakeman. *Modern Agricultural Mechanics*. 2nd ed. Danville, IL: Interstate Publishers, Inc., 1991.

Cooper, Elmer L. *Agricultural Mechanics: Fundamentals and Applications*. 2nd ed. Albany, NY: Delmar Publishers, Inc., 1987.

Equipment, Supplies, Materials

simple shop project (feed scoop plan in Cooper book)
materials for project (refer to bill of materials)
hand tools necessary to complete project

Presentation

A. Introduction

Nails and glue are not useful in bonding metals with one another. When metal is to be joined together or with another type of material, bolts, certain type of screws, rivets, solder, and welding are used. This lesson discusses some of the principles and safety rules used when working with metals.

B. Motivation

Acquire several different types of metals, and have at least three samples of each. Label one as control and the others as experimental. Clean all the pieces as if you were going to weld, braze, solder, or paint. Place the control samples in a clean and airtight environment. Expose the other pieces to either oxidation, oil, grease, paint, or any other foreign substance. Conduct several experiments involving a bonding process of the metals, through welding, soldering, etc., by using the control metal and then the experimental metal. Have students determine which bonded better and more easily, the control or experimental. Note: Prepare metals in advance.

C. Assignment

Using suggested shop plan or another of choice, have students construct a project.

D. Supervised Study

Have students clean pieces of metal by using each of the following methods: scraping, filing, sanding, wire brushing, and flux.

E. Discussion

1. *Question: What are the safety rules to follow when working with metal?*
   Answer:
   - Wear proper clothing and eye protection.
   - Use tongs or pliers for carrying hot metal.
   - Never touch suspected hot metal.
   - Avoid doing hot metal work around flammable material.
   - When cutting, filing, or chiseling metal, place in a vise or clamp.
   - Obtain instructor's permission before using equipment.
   - Use files with handles.
   - Avoid tools with mushroomed heads.
   - Keep cutting-edge tools sharp.
   - Avoid hammers with loose heads.

2. *Question: Why is it important to clean and prepare metal before usage?*
   Answer: Cleaning metal is most commonly done to improve the bonding power when being welded. Other reasons are for improving appearance, paint sticking capabilities, and removal of rough edges.

3. *Question: What are some methods used to clean metal?*
   Answer: There are two major categories for cleaning metal. The first is by physical means and the second is by chemical means. Physical cleaning can be done by scraping, filing, sanding, wire brushing, or grinding. Chemical cleaning can be done by using a cleansing agent called flux.

4. *Question: How is metal marked for cutting?*
   Answer: Common ways are by using a scratch awl, chisel, center punch, or soapstone. To make the marks more visible, layout fluid is often painted on the area resulting in a colored surface, most often blue. Reinforce the usage of the above methods during construction of project.

F. Conclusion

In this lesson, some of the basic practices used in beginning metal working were discussed. Safety is extremely important because of the nature of the material.

H. Evaluation

Evaluate students projects and safety tests. (Test 7VA 6.3)

Lesson 6.4 Reading and Interpreting Simple Plans

Student Objective

1. Discuss the importance of drawing a plan.
2. Define basic terminology related to plan drawing.
3. Interpret a simple plan.
4. Determine material needed to construct a project.
5. Sketch a simple project.

References

Burke, Stanley R. and T. J. Wakeman. *Modern Agricultural Mechanics*. 2nd ed. Danville, IL: Interstate Publishers, Inc., 1991.

Cooper, Elmer L. *Agricultural Mechanics: Fundamentals and Applications*. 2nd ed. Albany, NY: Delmar Publishers, Inc., 1987.

Phipps, Lloyd J. and Carl L. Reynolds. *Mechanics in Agriculture*. 4th ed. Danville, IL: Interstate Publishers, Inc., 1990.

Equipment, Supplies, Materials

pencils
rulers
graph paper
unlined white paper
drawing board
T-Square
45 and 30-60 triangle

Presentation

A. Introduction

A major part of basic laboratory skills is being able to read a set of plans in order to construct a project, such as a club house, skateboard ramp, dog house, etc. In following these plans, it is necessary to determine the item or part name, number of pieces needed, type of material, and size. Also, type of tools and cost must be considered. This lesson examines reading and interpreting simple plans.

B. Motivation

1. Place various shapes of small objects around the classroom or laboratory. Number them in sequential order. Provide students with a sheet of paper that shows each object's top, front, and end view. Have the students match the object with the correct orthographic drawing.
2. Pass out several simple laboratory project plans to the class. Ask each person to determine something about the plan, such as: How much wood is needed? How many screws? What is the size of the project? Present an award to the student who is most accurate.

C. Assignment
(To be done at end of lesson. Have students sketch a simple project to be constructed (chosen either by the student or instructor). The sketch should include correct dimensions and a simple bill of materials.

D. Supervised Study
Using one of the suggested references, provide basic instructions on procedures for mechanical drawing. Work with students on using mechanical drawing equipment for lines, lettering, and isometric pictorial drawings.

E. Discussion
1. *Question: Why is it important to draw or sketch a project before starting work?*
Answer: If you build a project without having developed a sketch or drawing, you have no guidelines to follow. It is hard to visualize the length or how many boards are needed. Having a plan before you begin work helps to establish what materials are needed. A plan also helps in avoiding costly mistakes. Not using plans is like trying to find someplace new without directions or a map.

2. *Question: What is the difference between a sketch and a drawing?*
Answer: A sketch is a rough drawing of something done very quickly and without much detail. A drawing is a more exact picture; it includes exact sizes drawn to scale with the aid of drawing equipment.
Suggested Activity: To further illustrate, have students sketch an object of their choosing. Then have students draw the same object, including detail. Another possibility is to identify specific things that could be classified as a drawing or a sketch.

3. *Question: What does it mean to draw to scale?*
Answer: Drawing to scale is done by drawing the object at a size proportional to the actual size. Most objects are larger than an 8 1/2" X 11" piece of paper. In order for the object to fit on the paper it is drawn smaller by using a standard measuring scale. An example of this standard measure is seen on road maps where 1 inch is equal to a certain number of miles. When drawing a project, assume 1 inch is 1 foot.

4. *Question: How do you use a project plan to determine the materials necessary for construction?*
Answer: The bill of materials provided with the plans will give you the necessary information. If you are using your own plan you will have to make your own bill of materials.

5. *Question: What is a bill of materials?*
Answer: It is list of all the materials necessary to build a project.

6. *Question: How do you read a bill of materials?*
Answer: Use transparency master 7VA 6.4 to show the various parts of a bill of materials.
Suggested Activity: For practice, provide students a simple project plan with the bill of materials missing and have them develop one.

F. Other Activities
Depending on class capabilities, work with students on drawing an isometric three-view drawing of some simple projects.

G. Conclusion
In building a project, the plan must come first. Drawing a plan takes time, but as skills increase, it becomes easier.

H. Evaluation
Evaluation of this lesson can be done by grading the project plans recommended in the assignment section.

Lesson 6.5 Identifying and Using Basic Hand Tools for Woodworking

Student Objectives

1. Identify the two main ways tools are classified.
2. Identify the major tool-function classifications.
3. Demonstrate the proper use of selected hand tools.

References

Burke, Stanley R. and T. J. Wakeman. *Modern Agricultural Mechanics*. 2nd ed. Danville, IL: Interstate Publishers, Inc., 1991.

Cooper, Elmer L. *Agricultural Mechanics: Fundamentals and Applications*. 2nd ed. Albany, NY: Delmar Publishers, Inc., 1987.

Phipps, Lloyd J. and Carl L. Reynolds. *Mechanics in Agriculture*. 4th ed. Danville, IL: Interstate Publishers, Inc., 1990.

Equipment, Supplies, Materials

at least one example from each of the tool classification groups

Presentation

A. Introduction

In this age of modern technology, one thing remains constant. People at one time or another have to use some type of hand tool. The tool could be anything from a hammer to a hacksaw. And though there are numerous power devices available, there is always the need for a hand tool. This lesson discusses basic hand tools, their functions, and proper usage.

B. Motivation

Select 10 common hand tools that should be recognizable to students. Develop three or four questions about each tool (e.g., for a hammer: Is this tool used to drive or is this tool used by moving the forearm up and down?). Split the class into teams and have a class competition.

C. Assignment

Divide class into groups of four. Using a method of cooperative learning, assign or have students choose several tools to learn about. Have each group teach the class about the development, history, and use of the tools.

D. Supervised Study

After tools have been identified and proper usage demonstrated, provide opportunities for students to practice using the tools.

E. Discussion

1. *Question: What is a hand tool?*
   Answer: A hand tool is any tool operated by hand to perform work. It is not to be confused with a tool held in the hand, and operated by a power source.

2. *Question: How are hand tools classified?*
   Answer:
   User
   Function
   User is described as what type of person would use the tool. Being a society of "do-it-yourselfers" and "fix-it-uppers", most any type of person could be found using a hand tool. *Function* is related to the type of work for which the tool is used.

3. *Question: What are the major tool-function classifications?*
   Answer:
   - Layout: measure or mark wood, metal, or other materials
   - Cutting: cut, chop, saw, or remove materials
   - Boring: make holes or change the size or shape of holes
   - Driving: move another tool or object
   - Holding: grip wood, metal, plastic, etc.
   - Turning: turn nuts, bolts, screws
   - Digging: loosen or remove a substance such as rock, or soil

4. *Question: Using the function classifications, what are examples of tools that fit into each category?*
   Answer:
   - Layout: ruler, try square, divider, level
   - Cutting: handsaw, wood chisel, block plane, flat file, hole saw
   - Boring: handdrill, bit brace, auger bit, countersink
   - Driving: curved claw hammer, wooden mallet, center punch, ball peen hammer
   - Holding: bench vise, block clamp (handscrew), visegrip pliers
   - Turning: standard screwdriver, adjustable wrench, ratchet handle, hex keys
   - Digging: shovel, post-hole digger, bulb planter, garden hoe

   This list is only a sample of specific tools. Depending on the type of wood project that students will be constructing, other examples may be more relevant. Keep in mind that some common tool names are not actually the correct tool name.

5. *Question: What is the correct use of these tools?*
   Answer: Demonstrate the proper use of each tool. If the cooperative learning exercise was used, have students conduct the demonstrations.

F. Other Activities
   1. Have a spelling bee using the tool names.
   2. Conduct the exercise suggested in the motivation section. Increase the number of tools to 15 or 20, and award prizes to the student(s) who correctly name and spell the most tools.

G. Conclusion
   Hand tools are a part of daily life. Proper usage protects against injury and extends the life of the tools.

H. Evaluation
   Provide a skill test for each tool. Have student demonstrate correct usage.

Lesson 6.6 Maintaining Hand Tools

Student Objectives

1. Explain the importance of maintaining tools.
2. Identify causes of tool breakdown.
3. Recondition a tool.

References

Burke, Stanley R. and T. J. Wakeman. *Modern Agricultural Mechanics*. 2nd ed. Danville, IL: Interstate Publishers, Inc., 1991.

Cooper, Elmer L. *Agricultural Mechanics: Fundamentals and Applications*. 2nd ed. Albany, NY: Delmar Publishers, Inc., 1987.

Phipps, Lloyd J. and Carl L. Reynolds. *Mechanics in Agriculture*. 4th ed. Danville, IL: Interstate Publishers, Inc., 1990.

Equipment, Supplies, Materials

dull tools
tools needing repair
handles for tools

Presentation

A. Introduction

Hand tools that have not been maintained properly can cause injury or cost money. For example, using a hammer with a loose head or cracked handle can result in someone being injured by a flying hammer head. A screwdriver with a misshapen tip or cracked handle can result in an injury to a hand. Also, money and time can be wasted when a tool has to be replaced. These problems can be avoided if tools are maintained properly. This lesson discusses maintaining hand tools.

B. Motivation

1. Demonstrate cutting a board with an extremely dull hand saw or drill bit. Then demonstrate the same cut with a sharp saw or drill bit.
2. Bring in a rusty tool (the rustier the better). Using naval jelly, wire brush, or some other means, proceed to clean the tool to its original condition.
3. Bring in a shovel which is half clean to allow students to see the contrast.

C. Assignment

At the completion of the lesson, have each student to recondition a selected tool.

D. Supervised Study

Individually or as a class, read pages 228-237 in *Agricultural Mechanics*. Require students to copy the directions for reconditioning at least two tools. Demonstrate the repairing

and reconditioning of some basic hand tools.

E. Discussion

1. *Question: Why is it necessary to maintain hand tools?*
   Answer: Well maintained tools are safer, last longer, and produce higher quality work than tools that are kept in poor condition.

2. *Question: What are some things that cause tools to deteriorate?*
   Answer: Normal use, rust, abuse, or misuse cause tools to deteriorate.

3. *Question: What is tool fitting?*
   Tool fitting means to clean, reshape, resharpen, or repair a tool. When a tool falls into one of these categories, it is reconditioned so that it can be used again.

4. *Question: What are examples of tools that might need continued reconditioning and what are some methods for reconditioning?*
   Answer:
   - Broken or cracked handles on hammers, shovels, axes, hatchets, rakes, or hoes: replace or repair
   - Nicked or dull cutting edges on lawn mower blades, knives, wood chisels, scissors, pruning shears, or tinsnips: grinding, bench stone, or filing
   - Rusted tools such as shovels, hand posthole digger: naval jelly, kerosene, wire brush, steel wool, or 400-600 grit silicon carbide paper.
   - Misshaped tools and tool heads such as chisels, screwdrivers, or punches: grinding

   Emphasize that some tools may need to be reconditioned by more than one method.

F. Other Activities
Collect hand tools that need to be reconditioned from students, other teachers, community members, and have students repair them as a service project.

G. Conclusion
If hand tools are taken care of properly, they can be used for a long time. This can save money and allow investment in new tools.

H. Evaluation
Use exercise in the assignment section for evaluation.

Lesson 6.7 Selection and Use of Measuring Tools

Student Objectives

1. Identify common measuring devices used in woodworking, metal working, and laboratory experiments.
2. Explain the difference between direct and indirect measuring devices.
3. Correctly use various measuring devices to determine length, depth, volume, and mass.

References

Burke, Stanley R. and T. J. Wakeman. *Modern Agricultural Mechanics*. 2nd ed. Danville, IL: Interstate Publishers, Inc., 1991.

Cooper, Elmer L. *Agricultural Mechanics: Fundamentals and Applications*. 2nd ed. Albany, NY: Delmar Publishers, Inc., 1987.

Heimler, Charles H. and Jack Price. *Focus on Physical Science*. Columbus, OH: Merrill Publishing Company, 1989.

Lee, Jasper L. and Diana L. Turner. *Introduction to World Agriscience and Technology*. Danville, IL: Interstate Publishers, Inc., 1994.

Phipps, Lloyd J. and Carl L. Reynolds. *Mechanics in Agriculture*. 4th ed. Danville, IL: Interstate Publishers, Inc., 1990.

Tools For Measuring–Wood (Video). Available from St. Paul, MN: Hobar Publications.

Equipment, Supplies, Materials

TV/VCR
examples of measuring devices

Presentation

A. Introduction

Measuring involves not only length, width, and height, but also volume, mass, weight, density, and temperature. The English system or U.S. Customary System is the standard way to measure in the United States. This system uses devices designed to measure inches, feet, and yards. The metric system is more common to the scientific community. Metric devices measure in units of millimeters, centimeters, grams, milliliters, and liters. This lesson involves learning how to select and use the appropriate measuring device.

B. Motivation

1. Show video *Tools For Measuring–Wood*.
2. Design an exercise requiring students to determine the length, width, height, volume, weight, etc., for various materials using a specific measuring device. Use some devices that are fairly common and others not so common. The exercise should stimulate student interest by posing unusual problems.
3. Have students measure certain objects in the classroom or lab using some other device than a ruler or scale as a standard.

C. Assignment
Students will be required to use skills learned in this subject for construction of a project.

D. Supervised Study
Before discussing how to use measuring devices, check students understanding of the basic principles of measuring. If necessary, review reading a ruler before beginning this lesson.

E. Discussion
1. *Question: What are some common measuring devices used in the laboratory?*
Answer:
   - Measuring sticks: folding rulers, steel tapes, bench rules
   - Calipers: inside, outside, dial, vernier
   - Gauges: sheet metal, wire, drill bit, spark plug, feeler
   - Squares: framing, try, combination,
   - Scales: balance, mechanical, electronic
   - Labware: flasks, beakers, graduated cylinders

2. *Question: What is the difference between direct and indirect measuring devices?*
Answer: Direct measuring devices are those that provide the measuring scale on the device. Examples would be rulers, micrometers, and graduated cylinders. Indirect measuring devices do not provide a measuring scale. These devices are used to determine measure and then transferred to a rule or scale. We commonly think of string, dividers, simple calipers, and even arms or hands as indirect measuring devices.

3. *Question: How are these measuring devices used?*
Answer: Provide each student or group of students (no more than three), with samples of measuring devices that fit into each of the categories above. Demonstrate how each is used, then provide exercises that allow the students to practice usage. Monitor students to ensure they correctly use various measuring devices to determine length, depth, volume, and mass.

F. Other Activities
1. Implement skills learned in this lesson in the construction of a project.
2. Provide measuring situations in which students will have to demonstrate knowledge of measuring skills.

G. Conclusion
Measurements are a daily part of life. Measuring takes place in the laboratory, home, classroom, and driving down the road. Measurements are sometimes taken directly and other times taken indirectly. In the agricultural laboratory, measurement is extremely important when working with solids and liquids. Success of activities depends upon the accuracy of measurements.

H. Evaluation
Evaluate construction of a laboratory project. Place emphasis on the measurements. Check for understanding of reading a ruler by providing a measuring exercise using various lengths of wood pieces.

Lesson 6.8 Selecting and Using Wood Fasteners

Student Objectives

1. Define basic words.
2. Identify common fasteners in wordworking.
3. Select and use correct wood fasteners for job.

References

Burke, Stanley R. and T. J. Wakeman. *Modern Agricultural Mechanics*. 2nd ed. Danville, IL: Interstate Publishers, Inc. 1991.

Cooper, Elmer L. *Agricultural Mechanics: Fundamentals and Applications*. 2nd ed. Albany, NY: Delmar Publishers, Inc., 1987.

Phipps, Lloyd J. and Carl L. Reynolds. *Mechanics in Agriculture*. 4th ed. Danville, IL: Interstate Publishers, Inc., 1990.

Equipment, Supplies, Materials

selected fasteners

Presentation

A. Introduction

When early man wanted to join a piece of rock to a stick to make a spear or hatchet, he most likely tied the two together with strips of leather, vines, etc. Frames for huts or tents were usually tied as well. This method worked, but it was not as strong as it could have been. Early settlers used wooden pegs and mud or clay to join house frames together. With the discovery of iron ore, new methods of joining wood became available. This lesson discusses types of fasteners used in woodworking and how to select the best one for the job.

B. Motivation

1. Have a medium sized wood project assembled in front of the classroom but do not use fasteners to hold it together. Make sure the class cannot tell it is not permanently together. Have a student pick it up to move it. After the commotion dies down, talk about why it came to pieces.
2. Have students assemble a project using tape. Have them determine its strength level or holding ability. Ask students to form conclusions as to why the tape worked or did not work. If possible have different types of tape available.

C. Assignment

Construct a project which requires the use of fasteners. This same project can be used in conjunction with other lessons in this unit.

D. Supervised Study

Work in groups of four to identify types of fasteners.

E. Discussion

1. *Question: What is a fastener?*
   Answer: A fastener is anything that is used to hold two or more pieces of material together. Common fasteners are glue, nails, screws, and bolts.

2. *Question: What are some common fasteners used in woodworking and how are they identified?*
   Answer:

   Nails Nail sizes are identified by a lower case *"d"* and referred to as penny-weight. The "penny" system originated in England. There are two explanations for how this name came about. The explanation for use of the *"d"* is that *"d"* is the symbol for penny, thus the weight of 1,000 six-penny nails is six pounds. The word "penny" came from the number of pennies that were used to buy 100 nails of a given size.
   Nails are classified according to their usage and are selected based on the desired holding ability, and the desired head shape.

   Screws Screws are classified in the following ways: By the material they hold; by the metal they are made from; by the shape of their head; and by the tool used to turn them. The length and diameter of the screw body are important in providing the size of the screw.

   Bolts Bolts differ from nails and screws by having a threaded nut. Bolts are more commonly used when strength is desired, or when frequent re-tightening and dismantlement is required. The type of bolt selected depends on the usage.

   Hinges Hinges are used for connecting wood objects together.

   Glue Glue is used in woodworking for several reasons. It can serve as a substitute when nails and screws are not suitable. It can also be used in addition to nails and screws for better holding power. A bond formed by glue is usually stronger than the wood itself. There are several types of glue; selection depends on usage.

3. *Question: What are some commonly used nails and examples of their uses?*
   Answer:
   - Common nail: general construction, sheeting, board fencing
   - Finishing nail: interior finish, trim, furniture,
   - Box nail: light construction, siding, crates

   Have a sample of each for the students to see.

4. *Question: What are some common types of screws and their uses?*
   Answer:
   - Flat, round, and oval wood screws: joining or holding wood pieces
   - Sheet metal: used for thin metal
   - Lag screws: used for fastening wood to brick and concrete, or metal to wood

   Have a sample of screws available for students to see. Discuss when it is more suitably to use a flat head screw instead of a round or oval and vice versa.

5. ***Question:*** What are some common bolts used in woodworking and when are they best used?

Answer:

- Machine: used for machinery, works best where periodic retightening is necessary
- Carriage: bottom part of bolt head is pulled into wood to prevent turning, used in construction of doors, wagon bodies
- Stove bolt: used for lightweight structures, threaded entire length, has a screwdriver slot on head

Have students identify samples.

6. *Question: How do bolts differ from wood screws?*
   Answer: Bolts are usually threaded about 1 inch at the end and use a tap or nut to hold material together. Wood screws are self-tapping; the threads are used to hold to material.

7. *Question: Why are hinges sometimes used instead of screws, bolts, or nails?*
   Answer: Hinges allow for wood to move back and forth. Doors (house, locker), lids, and gates are examples of wood objects that use a hinge. Some common types of hinges are the butt, strap, hasp, and T-hinge.

8. *Question: What benefits are there in using glue?*
   Answer: Glue can be used with other types of fasteners previously discussed, or it can be used in place of the other fasteners. There are several types of glues to choose from. Selection depends on use. If glue is used in addition to other fasteners, the bond formed is much stronger than the wood itself. Glue works better for furniture assembly, and glued pieces are more suitable for planing than nailed pieces.

9. *Question: What are some common glue types and examples of uses?*
   Answer:
   - White glue: wood, paper, cloth,
   - Plastic–resin: wood and leather
   - Resorcinol: outdoor furniture and wood
   - Contact cement: wood, plastics

   Let students determine water resistance and strength by conducting experiments. Suggested Activity: Select wood samples or other suitable materials and glue. Allow to dry correct time period. Student(s) should have two glued samples for each of the types of glue described. Expose one group of the samples to water and the other to a strength test. Students should develop hypotheses before beginning tests.

F. Other Activities
   Participate in an agriscience technology contest.

G. Conclusion
   When selecting what type of fastener to use, consideration should be given as to where it is to be used and the purpose for using it. Determining these two things will make selection easier.

H. Evaluation
   After construction of laboratory project, evaluate use of fasteners as to type and strength.

Lesson 6.9 Finishing and Preserving Wood

Student Objectives

1. Identify and conduct steps necessary to prepare wood for finishing.
2. Select and apply finishes.
3. Select proper sandpaper.

References

Burke, Stanley R. and T. J. Wakeman. *Modern Agricultural Mechanics*. 2nd ed. Danville, IL: Interstate Publishers, Inc. 1991.

Cooper, Elmer L. *Agricultural Mechanics: Fundamentals and Applications*. 2nd ed. Albany, NY: Delmar Publishers, Inc., 1987.

Equipment, Supplies, Materials

samples of sanded wood blocks
samples of decayed or diseased wood
sandpaper (80, 100, 120, 220, 280)
steel wool (000 grade)
selected preservative (polyurethane, shellac, paint, stain)
pure bristle paint brushes
solvent or thinner
Amount needed will depend on class size and project dimensions.

Presentation

A. Introduction

There are several reasons for finishing and preserving wood. One is to protect it from decay. Another is to beautify it, and still another, to repair or restore it. This lesson deals with finishing and preserving wood.

B. Motivation

1. Bring in several pieces of wood that show evidence of decay from such things as insects or weathering. Give the students an opportunity to suggest ways to prevent this from happening to other wood.
2. Prior to class sand five blocks of wood each with a different grit of sandpaper (more than one set per class may be needed). Provide students with samples of the various sandpaper that were used to sand the wood blocks. Have a contest to see who can correctly match the wood blocks with the sandpaper.

C. Assignment

Complete steps in wood finishing and preserving for the project constructed in the laboratory.

D. Supervised Study
Provide students with a sanding block, sandpaper, and scrap wood. Have them practice sanding in order to check for correct grit usage and direction of sanding (with the grain).

E. Discussion
1. *Question: Why is it necessary to finish and preserve wood?*
Answer: There are several reasons for finishing and preserving wood. The main reason is to protect it from decay caused by insects, bacteria, fungi, water, and other harmful elements. Another reason is to bring out the natural beauty of the wood. Stains allow a person to change the original color of a piece of wood to match an already existing piece. During construction wood can be harmed by dirt, pencil marks, glue, and dents. Often wood is broken. Finishing techniques and preservatives allow the woodworker to correct or remove some of these mistakes.

2. *Question: What are some of the basic materials needed for finishing and preserving wood?*
Answer: If you plan on finishing and preserving wood, the following items are basic to every home shop:
dust mask
sandpaper: several grits (100, 120, 220)
electric or hand sander
wood clamps
steel wool
good quality brushes
preservative: shellac, varnish, polyurethane, lacquer, stains, etc.
solvent or thinner: type depends on preservative used

3. *Question: What are the basic steps for finishing and preserving wood?*
Answer:
a. Check wood for marks, dents, holes, or other defects that would flaw the finished product.
b. Correct these if found. (Note: Pencil marks should be erased, sanding embeds them into the wood. Use wood putty sparingly.)
c. Select a medium grit (100) sandpaper and sand until all marks are removed. If marks are not being removed, try an 80 grit paper. Follow this with 120 grit. Make sure that the final sanding is done with the grain.
d. Blow off excess dust with an air compressor and then wipe down with the grain.
e. Cover an area with paper or dropcloth to protect from spills.
f. Support wood on scrap pieces.
g. Select a finish.
h. Select a brush for application. (Pure bristle brushes work best in most cases, except with latex paints).
i. Carefully read all the directions.
j. Dip about 1/2 of the bristles into the material.
k. Apply using a back and forth motion, alternating between dipping into material and applying it to the wood.
l. When finished, clean brush in the appropriate solution. End by washing the brush with soap and warm water.
m. Allow the wood to dry the amount of time as directed on the preservative label.

n. Rub the surface with a 000 grade steel wool or fine sandpaper (280) until the surface is smooth.
o. Repeat steps h through o until the desired finish is reached.
p. If desired, use paste wax as the final finish.

4. *Question: What are some of the most common materials used for sanding wood?*
Answer:
- Garnet: used for hand sanding
- Aluminum oxide: machine sanding
- Steel wool: smoothing and polishing

5. *Question: What are some common preservatives on the market today?*
Answer:
shellac
varnish
polyurethane
lacquer
wood stains
polyshades

6. *Question: What determines the type of preservative to be used?*
Answer: The type of preservative to be used depends on the purpose of the wood and the results desired. Natural finishes usually are achieved by clear varnishes, polyurethane, or shellac. Wood stains are used when the purpose is to enhance the wood grain or change the natural color. If the wood is to come in contact with water, varnish is the most desirable.

F. Other Activities
Construct a wood project to enter in the county or state fair.

G. Conclusion
Finishing and preserving wood enables it to last a long time. This lesson detailed how to finish and preserve wood.

H. Grade students on their ability to correctly finish and preserve a wood project.

General Laboratory Safety Test

Name_____
Date_____

TRUE OR FALSE: Circle the correct letter.

T F 1. Horseplay is dangerous in the laboratory.

T F 2. Secure all work before beginning a task.

T F 3. More force is necessary when cutting with a sharp tool.

T F 4. Federal law requires you to wear safety glasses.

T F 5. It is acceptable to throw tools to each other.

T F 6. A wrench can be used to hammer nails.

T F 7. A clean laboratory is a safe laboratory.

T F 8. A dirty file will not cut as well as a clean file.

T F 9. Guards and shields protect your hands from being cut.

T F 10. Sharp tools and pointed tools should be passed to another person handle first.

T F 11. File handles are designed to extend the length of the file.

T F 12. Serious injury can occur if safety rules are not followed.

T F 13. Hot metal can severely burn skin and clothing.

T F 14. When working with power tools, use one hand to held the material.

T F 15. When welding, regular safety glasses will protect your eyes from the arc.

Answer Key

1. T
2. T
3. F
4. F
5. F
6. F
7. T
8. T
9. T
10. T
11. F
12. T
13. T
14. F

Common Metals and Alloys

	Description	Uses
Aluminum	silver–white, light metal, strong, good conductor of heat and electricity	automobile, pots and pans, electric wires, airplanes, foil, siding, roofing
Brass	Ductile, acid resistant, malleable	water valves, ornaments
Bronze	soft, malleable, corrosion resistant, copper in color	ornaments
Cast iron	brittle, strongly magnetic, dull gray, melts slowly	machinery parts, engine blocks, wood stoves
Copper	tough, malleable, reddish brown color, corrosion resistant	pipe, rain spouts, electrical equipment, gutters, excellent for conducting electricity
Galvanized steel	steel with a zinc coating	water tanks, roofing, siding, fencing
Lead	soft, heavy, bluish gray, toxic	batteries, bullets, cable covering, solder
Mild steel	dark gray, malleable, ductile, tough, magnetic, melts fast	structural steel
Stainless steel	bright, silvery, smooth, hard, tough, very corrosion resistant	food handling equipment, milktanks, restaurant equipment, surgical instruments, knives
Tin	silver color, very malleable, corrosion resistant	used in alloy–solder, bronze, pewter, set dye in cloth, add weight to silk
Tool steel	high carbon content, heat treatable, expensive	cutting tools, drill bits, saw blades
Wrought iron	rust resistant, tough, light gray, strongly magnetic	decorative fences, railings

Metalworking Safety Test

Name_____
Date_____

TRUE OR FALSE: Circle the correct letter.

T F 1. Treat hot metal with care.

T F 2. Sharp cutting tools work more efficiently.

T F 3. A hammer with a loose head is an accident waiting to happen.

T F 4. Only use a vise to hold work when you need both hands to operate the tool.

T F 5. Leather clothes are the best way to carry hot metal.

T F 6. Eye protection is not necessary for metal working.

T F 7. Mushroomed heads on tools can cause serious injury.

T F 8. Secure the instructor's permission before using tools.

T F 9. Hot metal and flammable materials do not go together.

T F 10. Files should be used with handles.

Metalworking Safety Test
Answer Key

1. T
2. T
3. T
4. F
5. F
6. F
7. T
8. T
9. T
10. T

Bill of Materials

ITEM	NO. OF PIECES	SIZE	DESCRIPTION	TOTAL FEET	UNIT COST	TOTAL

DUTY AREA 7: OVERVIEW
Encouraging Personal Development

- **Competencies/Tasks**
  - 7.1 Identify effective leadership traits.
  - 7.2 Identify personal development needs.
  - 7.3 Develop oral communication skills.
  - 7.4 Develop written communication skills.
  - 7.5 Develop an understanding of FFA.
  - 7.6 Develop opportunities for leadership.
  - 7.7 Develop social skills.

- **Lessons**
  - 7.1 Effective Leadership Traits
  - 7.2 Personal Development Needs
  - 7.3 Oral Communication Skills
  - 7.4 Written Communication Skills
  - 7.5 Understanding the FFA
  - 7.6 Opportunities for Leadership
  - 7.7 Developing Social Skills

- **Evaluation**
  Suggestions for evaluation appear at the end of each lesson.

DUTY AREA 7
Encouraging Personal Development

Lesson 7.1 Effective Leadership Traits

Student Obtain

1. Identify basic leadership traits.
2. Describe an effective leader.
3. Demonstrate effective leadership skills.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications*. Albany, NY: Delmar Publishers, Inc. 1990.

FFA Student Handbook. Alexandria, VA: National FFA Organization, latest edition.

Equipment, Supplies, Materials

FFA Student Handbook (Copy for each student)
list of simple problems that need solving
bulletin board display
next FFA meeting program
prizes to be given for a contest
rules for a poster contest

Presentation

A. Introduction

Opportunities for leadership can be found almost anywhere. Leaders can be found in clubs, sports, classes, churches, and jobs, just to name a few. Being a good leader required certain traits and skills, which this unit will explore.

B. Motivation

1. Identify people who are considered to be leaders, and identify their leadership characteristics.
2. Display pictures of leaders, including local and school leaders. Quiz students on their common characteristics.

C. Discussion

1. *Question: What is meant by leadership?*
   Answer: It is the ability to lead.
   Have students provide their own definition first.

2. *Question: Why are leadership skills important?*
   Answer: Leadership skills are not just necessary for people who are in charge of groups. Leadership skills are helpful in landing a first job, getting promoted, and getting along well with people. These skills can also help build self-confidence and improve the ability to communicate.

3. *Question: What are some traits of a good leader?*
   Answer:
   honesty
   knowledge
   courage
   tact
   enthusiasm
   unselfishness
   loyalty
   Students may name other terms that describe the traits of a good leader.

4. *Question: How can good leaders be recognized?*
   Answer:
   - They get along with other people.
   - They understand other people's feeling.
   - They listen to other opinions.
   - They are well prepared and organized.
   - They accept responsibility.
   - They are group-oriented.

D. Other Activities
   1. Split the class into small groups of no more than five. Assign each group a problem that needs to be solved. (If the problem relates to the students, they will be more likely to find a solution.) Give each individual in the group at least 10 minutes to have a turn at being the group leader. After a solution has been reached have the group evaluate each other's performance at being a leader based on items identified as being traits and characteristics of a good leader.
   2. Have each student attend a meeting in the local community to observe the leadership skills demonstrated.

E. Conclusion
   Leadership is acquired through an understanding of, and experience in the leadership role. These skills may be applied throughout life.

F. Evaluation
   Quiz questions can be developed from this lesson. An evaluation is provided at the end of the unit.

Lesson 7.2 Personal Development Needs

Student Objectives

1. Discuss what personal development means.
2. Identify major areas of personal development.
3. Discuss ways to improve personal skills.
4. Evaluate personal development.

References

FFA Student Handbook. Alexandria, VA: National FFA Organization, latest edition.

Equipment, Supplies, Materials

FFA Student Handbooks for each class member

Presentation

A. Introduction

A first impression is just that; it cannot be made upon subsequent meetings. Therefore, it is important for people to present their best. This lesson examines personal development as a means to that end.

B. Motivation

Give each student a few minutes to answer the question, "Who am I?" Have each student share his or her personal description with the rest of the class. Write key words that students use on the chalkboard or overhead projector.

C. Assignment

Have students identify things about themselves they would like to improve upon, as well as a plan for accomplishing improvements. Also, have students identify their strengths and how they achieved them.

D. Discussion

1. *Question: What is personal development?*
   Answer: It is the process of improving oneself through self-examination.

2. *Question: List several areas for self-improvement.*
   Answer:
   self-image
   personality
   social skills
   communication skills

3. *Specify ways to improve in these areas.*
   Self-image:
      self-confidence
      motivation
      goal-setting
      ability to change
   Personality:
      compatibility
      ability to be an extrovert
   Social Skills:
      good manners
      good grooming
   Communication:
      good speaking skills
      good writing skills
      good telephone skills
      good nonverbal skills
      good listening skills
   Expand on each of the above topics with exercises or examples.

E. Other Activities
   Complete a self-evaluation form.

F. Conclusion
   This lesson examined personal development. The next several lessons will detail communication and social skills.

G. Evaluation
   Use the evaluation provided at the end of the unit.

Lesson 7.3 Oral Communication Skills

Student Objectives

1. Identify ways of communicating orally.
2. Demonstrate ways of communicating orally.
3. Identify main parts of a speech.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications*. Albany, NY: Delmar Publishers, Inc., 1990.

FFA Student Handbook. Alexandria, VA: National FFA Organization, latest edition.

Shinn, George. *Leadership Development*. 2nd ed. New York, NY: McGraw-Hill Book Company, 1986.

Equipment, Supplies, Materials

public service announcements, 30 seconds in length
chewing gum

Presentation

A. Introduction

Begin chewing several pieces of gum, then greet the class and welcome them to today's lesson on oral communication. Point out that they are probably having difficulty understanding what is being said. Remove the gum. Note that this demonstrates the importance of not only having something to say, but of actually communicating it. This lesson focuses on ways to improve oral communicaiton skills.

B. Motivation

1. Have students pair off and exchange information about themselves. Then have each person introduce their partner to the class by giving information such as name, home, and career choices.
2. Show a video on effective communication. See the reference list for suggestions.

C. Assignment

Have students prepare and deliver a brief oral presentation to the class on a topic related to agriscience. They may work in pairs or alone to deliver a simple conversation, prepared speech, or telephone conversation.

D. Discussion

1. *Question: What are several ways of communicating orally?*
   Answer:
   prepared speaking
   casual conversation

2. *Question: In what situations is oral communication used?*
   Answer:
   with friends
   in meetings
   in class
   in assemblies

3. *Question: What makes speaking in public effective?*
   Answer: Careful preparation makes public speaking effective.

4. *Question: What are they key factors in delivering speeches?*
   Answer:
   preparation
   effective use of voice
   nonverbal communication
   organization

5. *Question: How can these factors be developed?*
   Answer:
   - Preparation:
     Plan ahead.
     Research topic if necessary.
     Rehearse.
   - Effective use of voice:
     Articulation: the ability to pronounce each word clearly
     Pitch: regulating the highness or lowness of voice to avoid speaking in a monotone
     Emphasis: making words stand out without using pitch
     Pace: speed at which one speaks
     Tone: saying words with feelings
   - Nonverbal communication:
     facial expressions
     eye contact
     appearance
     body language
   - Organization:
     opening
     body
     conclusion

E. Other Activities
   Have students work in groups to practice the following voice exercises:
   Articulation
   Practice these or other tongue twisters:
   -Rubber baby buggy bumper
   -She sells seashells by the seashore
   -Peter piper picked a peck of pickled peppers...
   -Let's push cushions with much lush plush.

Pitch

Practice raising and lowering your voice on this sentence.
Agriscience is an exciting class.

Emphasis

Repeat this sentence, placing the emphasis on different words.
You will do this work in groups.

Pace

Work on speaking pace by reading some prepared public service announcements that are about 30 seconds in length.

Tone

Try saying this sentence in the following ways: happy, surprised, shocked and angry.
What are you doing here?

F. Other Activities

Take students to a local radio station to tape 30-second public service announcements promoting a special event. Examples:

National FFA Week
National Farm Safety Week
Agriculture Week
National Vocational Week

G. Conclusion

Effective oral communication depends upon clear and understandable speech. It plays an important role in being successful and requires skill and practice.

H. Evaluation

Grade the oral communication exercise the student has selected. Quiz questions can be developed from the materials provided.

Lesson 7.4 Written Communication Skills

Student Objectives

1. Identify various types of written communication.
2. Identify important parts of written communication.
3. Demonstrate the ability to communicate in written form.

References

FFA Student Handbook. Alexandria, VA: National FFA Organization, latest edition.

Shinn, George. *Leadership Development*. 2nd ed. New York, NY: McGraw-Hill Book Company, 1986.

Presentation

A. Introduction

The previous lesson examined oral communication. Many times the success of oral communication depends upon the ability to write down thoughts in an organized manner. This lesson examines written communication skills.

B. Motivation

Write down directions for correctly setting a digital watch for the time, date, and alarm, omitting several of the important steps. Get a volunteer from the class to set the watch using only the directions provided. After student has gone through the steps, have another student check for accuracy. If all goes as planned, the watch will not be set correctly. Discuss reasons why the watch was not set accurately. Discuss the importance of accurate directions.

C. Assignment

Have students complete the following written assignments.

directions to their house
a letter to a FFA chapter to find out some of the activities they conduct
a thank you note

D. Discussion

1. *Question: What is the importance of writing?*
   Answer: It is an excellent way to express thoughts clearly when communicating.

2. *Question: What are the various ways we communicate in written form?*
   Answer:
   letters
   invitations
   reports
   thank you notes
   news articles

3. *Question: Good writing includes what three things?*
   Answer:
   clarity
   conciseness
   simplicity

E. Other Activities
   1. Have each student do a practice writing, such as a letter to a relative. Let students critique each other's letters following the criteria from answer A3.
   2. Work with the English department on grammar, spelling, and punctuation. Obtain worksheets to use with students.
   3. Have students use school computer lab to complete the writing assignment.
   4. Work with the science department for format on writing a research project report. Explain guidelines to students.
   5. Start a chapter newspaper with students.
   6. Have students write articles to send to the local newspaper on agriscience or FFA activities.
   7. Have students submit articles to the FFA New Horizons or the FFA news releases published by the Virginia State FFA Association.

F. Conclusion
   Even in today's high tech society, writing continues to be a major form of communication. As with oral communication, writing requires skill and practice.

G. Evaluation
   Evaluate the written work suggested in the assignment section.

Lesson 7.5 Understanding the FFA

Student Objectives

1. Define the FFA.
2. Discuss historical developments of the organization.
3. Describe the FFA emblem and colors.
4. Explain the meaning of the FFA Motto.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications.* Albany, NY: Delmar Publishers, Inc., 1990.

Dare to Dream (Video). Alexandria, VA: National FFA Foundation, 1991.

FFA is ... (Brochure). Alexandria, VA: National FFA Foundation.

FFA Student Handbook. Alexandria, VA: National FFA Organization, latest edition.

Official FFA Manual. Alexandria, VA: National FFA Organization, latest edition.

Equipment, Supplies, Materials

TV/VCR

FFA is ... (enough copies for each class member)

FFA Student Handbook (enough copies for largest class)

Presentation

A. Introduction

Students enrolled in agriscience classes have the opportunity to join the FFA. The FFA (Future Farmers of America) is a national organization designed to provide students with opportunities to apply the skills they learn in the classroom to the real world. This lesson explores the FFA.

B. Motivation

1. Show the video *Dare to Dream.*
2. Pass out copies of the brochure *"FFA is ..."* to each class member.

C. Assignment

1. Recite and explain the FFA motto to students.
2. Have students participate in one FFA activity.
3. Have students attend an FFA chapter meeting.

D. Supervised Study

Read Chapters 7 and 8 of the *FFA Student Handbook.*

E. Discussion

1. *Question: What is the FFA?*
   Answer: Though the FFA is commonly defined as a national organization for students enrolled in agriculture/agriscience curriculums, it is much more. It is about traveling, making new friends, earning money, working as a team, serving the community, winning, and most importantly, having fun.
   Give examples of the activities the local FFA conducts to tie in with the previously mentioned areas.

2. *Question: How was the FFA started?*
   Answer: Though the FFA officially began in Kansas City, Missouri in 1928, its beginnings started much earlier. The passage of the Smith-Hughes Act in 1917 began the funding of vocational education in the public schools. By 1926, Virginia had formed the Future Farmers of Virginia (FFV). Two years later the national organization was formed. Though there were four founders of the FFA, Henry C. Groseclose is called the father of the FFA. Refer to the latest edition of the Official FFA Manual for a chronological history of the FFA.

3. ***Question:*** *What symbols make up the FFA emblem?*
   Answer:
   - Cross-section of an ear of corn: represents our common interest in agriculture
   - Rising sun: represents the future and progress of agriculture
   - Plow: represents labor and working of the soil
   - Owl: represents knowledge and wisdom
   - Eagle: represents the national scope of the organization
   - Agricultural Education and FFA: represents that FFA is a part of the agricultural education program

4. *Question: What is the FFA motto?*
   Answer:
   Learning to do
   Doing to learn
   Earning to live
   Living to serve

5. *Question: What does the motto mean?*
   Answer: The FFA motto provides members with a foundation by which to live. As the motto states, one learns to do in the classroom, then applies the knowledge to get a job in order to make a living. The final line means that throughout life one should also contribute to the community.
   Give students an opportunity to provide their own meaning of the creed by means of a skit, poster, collage, or oral report.

6. *Question: What are the FFA colors?*
   Answer: National Blue and Corn Gold

F. Other Activities

1. Have students participate in the Middle School Agriscience FFA Quiz Bowl contest.

G. Conclusion
The FFA is about working together, serving the community, building character, and seizing opportunities. The next lesson discusses opportunities available through the FFA.

H. Evaluation
Grade motto projects and prepare a quiz on the FFA's history.

Lesson 7.6 Opportunities For Leadership

Student Objectives

1. Identify leadership opportunities.
2. Participate in at least one leadership activity.

References

Cooper, Elmer L. *Agriscience: Fundamentals and Applications.* Albany, NY: Delmar Publishers, Inc., 1990.

Dare to Dream (Video). Alexandria, VA: National FFA Foundation, 1991.

FFA is ... (Brochure). Alexandria, VA: National FFA Foundation.

FFA Student Handbook. Alexandria, VA: National FFA Organization, latest edition.

Official FFA Manual. Alexandria, VA: National FFA Organization, latest edition.

Presentation

A. Introduction

Lesson 7.1 identified leadership traits a person should have to be successful. This lesson looks at opportunities for leadership.

B. Motivation

Have students brainstorm to develop a list of all the possible ways to practice leadership.

C. Assignment:

Have students participate in at least one FFA activity at the local, state, or federal level.

D. Discussion

1. *Question: Where can leadership opportunities occur?*

   Answer:

   team contests
   role of officer
   committee meetings
   organizations
   FFA meetings
   leadership camps
   tutoring
   service activities

   This is only a partial list; students should come up with other ways.

2. *Question: What are some examples of activities and contests in the FFA that can help build leadership?*

   Answer:

   - Public speaking: oral and written skills
   - Parliamentary procedure: oral skills, thinking skills, and problem solving

- FFA Creed contest: oral and thinking skills
- Judging teams (Quiz bowl, Companion/Small Animal, Food and Fiber, Plant and Seed Identification, Agriscience Fair): stresses teamwork

Emphasize other contests chapter members may enter.

3. *Question: What officer positions are available to students in the FFA?*
   Answer: The FFA has six official officer positions:
   president
   vice-president
   secretary
   treasurer
   reporter
   sentinel

   Explain the duties of each officer.

4. *Question:* What are committees?
   Answer: Committees are small groups that meet to make decisions about activities. An example would be a committee set up to plan refreshments for the club meetings. The FFA has twelve committees that carry out various functions of the organization. Assigning students to serve on a committee will help them understand the functions of a committee.

5. *Question:* How can students improve their leadership?
   Answer: Other activities available are:
   - Join the FFA.
   - Go to meetings regularly.
   - Attend the middle school leadership camp.
   - Participate in a community service activity such as Building Our American Communities, or Food For America.

E. Other Activities
   1. Use each class to make up a mock FFA chapter.
   2. Allow students to select an FFA committee they would like to be on.
   3. Select officers for the chapter by using an interview process.
   4. Attend the Virginia Tech AES-FFA Leadership Conference or the Virginia State Leadership Conference in the fall.

F. Conclusion
   There are opportunities for leadership in everyday situations. This lesson explored some of these, yet there are many more.

H. Evaluation
   Use the sample test at the end of the unit for evaluation.

Lesson 7.7 Developing Social Skills

Student Objective

1. Identify proper grooming.
2. Identify proper manners.
3. Identify table manners.
4. Discuss why social skills are important.

References

FFA Student Handbook. Alexandria, VA: National FFA Organization, latest edition.

Shinn, George. *Leadership Development*. 2nd ed. New York, NY: McGraw-Hill Book Company, 1986.

Equipment, Supplies, Materials

mannequin
FFA Student Handbook

Presentation

A. Introduction

Social skills encompass dress, behavior, and interaction with other people. Manners are one way people have of viewing others. This lesson talks about various ways to develop a positive image in social situations.

B. Motivation

1. Borrow a mannequin from a local department store and bring in an assortment of casual and professional clothing, including accessories. Working in groups, have students dress the mannequin in casual and professional attire. Have the other groups write a critique.
2. After obtaining permission, videotape a group of people eating. Show the video to the class and have them note the good and bad manners they observe. After completing the discussion question on table manners, go over their answers.

C. Assignment

1. Using the *FFA Student Handbook* for directions, have each student tie a tie or scarf.
2. Have students evaluate table manners during their lunch period for use in a class discussion.

D. Discussion

1. Question: *Why are social skills important?*
   Answer: They build self-confidence, improve manners, show positive image, and improve relationships.

2. *Question: What are ways to maintain an optimum personal appearance?*
   Answer: Maintain personal cleanliness by bathing daily, keeping hair clean and combed, brushing teeth, and using deodorant. Also, make sure clothes are clean, neat, and fit properly.

3. *Question: What behavior is appropriate to demonstrate with other people?*
   Answer: Acting a certain way around people does not mean there should be pretense. It is important to be oneself, yet there are some guidelines which are helpful.
   Introductions:
   When meeting new people, smile, look them in the eye, shake their hand, and exchange names. When introducing one person to another, keep in mind: younger people are presented to older people; men are presented to women; and business or military people are presented in ranking order (assistant managers to company presidents, privates to majors).
   Conversation:
   Monopolizing conversation is not appropriate; nor are bad language, distasteful jokes, and gossip.
   Expand on this lesson by role playing introductions. You can also pair up students and have them practice introducing themselves to each other.

4. Question: *What are good table manners?*
   Answer:
   - Eat quietly and chew with a closed mouth.
   - Keep the napkin in your lap.
   - Wait until everyone is served before beginning.
   - Lift the food to your mouth.
   - Use the outside fork, spoon, or knife if there is more than one at your place setting.
   - Do not push plate away from you or lean back in chair when you are finished eating.

   More answers can be added. Review the video used in the motivation section. Check students' answers to see who had the most correct.

E. Other Activities
1. Work with the home economics department in conducting a social function or activity where students can apply the skills they have learned.
2. Have a banquet for the program, with the FFA as the theme. Require students to set tables and practice proper table manners during the meal.
3. Invite a resource person to come to class and discuss hygiene, dress, and social graces.

F. Conclusion
Improving social skills and changing bad habits may take time and experience. These changes, however, are of lasting value.

H. Evaluation
Provide a quiz on manners. Evaluate students' learning based on exercises in the assignment section.

Duty Area 7 Evaluation
Encouraging Personal Development

Name _____

Date _____

I. **True or False:** Circle the correct answer.

T F 1. Leadership is the ability to lead.
T F 2. Dictatorship is a characteristic of a good leader.
T F 3. Personality has no influence on being a better person.
T F 4. Self-image is how you feel about yourself.
T F 5. Facial expressions are a form of communication.
T F 6. Communication in large groups is not effective.
T F 7. Pitch is the ability to pronounce each word clearly.
T F 8. The official FFA colors are national blue and corn yellow.
T F 9. The FFA has seven official chapter officers.
T F 10. When being introduced, younger people have older people presented to them.

II. Circle the letter that corresponds to the best answer.

11. Which of the following is considered unacceptable table manners?
    A. Waiting until all have been served before beginning to eat
    B. Placing the napkin in your lap
    C. Bending your head over to reach the food
    D. Chewing with your mouth closed
12. Which of the following FFA contests can help build leadership?
    A. Food and Fiber contest
    B. Seed Identification contest
    C. Parliamentary Procedure contest
    D. All of the above are correct
13. Which of the following is not a symbol on the FFA emblem?
    A. Owl
    B. Eagle
    C. Tractor
    D. Rising sun
14. The ability to make words stand out without raising or lowering your voice is called _____.
    A. Tone
    B. Pace
    C. Articulation
    D. Emphasis
15. What is good writing?
    A. Clear, complex, concise
    B. Concise, clear, simple
    C. Simple, concise, short
    D. Clear, concise, brief

Complete the following short answer questions.

16. Describe a leader. (Include definition and traits.)

17. Where does communication take place?

18. Identify the various ways of communication.

19 Who is known as the father of the FFA?

20. Describe how the FFA was started.

Encouraging Personal Development Evaluation Answer Key

1. T
2. F
3. F
4. T
5. T
6. F
7. F
8. F
9. F
10. F
11. C
12. D
13. C
14. C
15. D
16. B
17. Answers will vary.
18. Answers will vary.
19. Henry C. Groseclose.
20. Answers will vary.

FFA Motto

Learning to Do

Doing to Learn

Earning to Live

Living to Serve

Appendices: Equipment Lists

Equipment List

Audio-visual equipment
Computer equipment
Forestry
Science laboratory
Agricultural engineering
Horticultural supplies
Hand tools
Power tools
Portable power tools
Welding
Aquaculture

Equipment List (Suggested)

Audio-Visual Equipment

1. Camera, 35mm
2. Projector, 16mm
3. Projector, Film strip
4. Projector, overhead
5. Projector, overhead with computer hookup
6. Television
7. Television-VCR combo
8. VCR w/remote
9. VHS camcorder

Computer Equipment

1. CD Rom
2. Disks, 3 1/2" and 5 1/4"
3. IBM compatible or Macintosh w/hard drive
4. Modem or fax modem
5. Monitor, Super VGA
6. Mouse
7. Printer, 24 Pin
8. Printer, Laser
9. Software, CAD
10. Software, educational
11. Software, encyclopedia CD
12. Software, graphics
13. Software, Microsoft Windows
14. Software, spreadsheet
15. Software, word processing
16. Sound Card w/speakers
17. Surge protector, electrical
18. Surge protector, modem
19. Video card, 1 meg

Forestry

1. Biltmore tree scale
2. Clinometers
3. Compass
4. Diameter tape
5. Increment borer
6. Leaf press
7. Planting bar
8. Plastic flagging

Science Laboratory

1. Beakers
2. Burner, electric
3. Calculators
4. Dissecting kit
5. Flower dissecting kit
6. Grow lights
7. Heat light
8. Incubator
9. Light meter
10. Magnifying glass
11. Microscope slides
12. Microscopes
13. Microscope, illuminated packet
14. Petri dish
15. pH Meter
16. Plant press
17. Root view growth chamber
18. Scales
19. Soil fertility analyzer
20. Soil moisture test
21. Soil test kit
22. Test tube holder
23. Test tubes
24. Tissue culture kit
25. Water test kit

Agricultural Engineering

1. Compass
2. Drawing boards
3. Drawing set
4. Farm level
5. Protractor
6. Surveying chain
7. T-square
8. Telescoping surveying rod
9. Triangle - 30x60x90
10. Triangle - 45x45x90

Horticultural Supplies

1. Bow saw
2. Bucket
3. Bulb planter
4. Cell packs
5. Chain saw
6. Compass
7. Diameter tape
8. Fans, circulation
9. Fertilizer, soluble
10. Flagging
11. flats
12. Garbage can, 32 gallon
13. Garden seeder
14. Greenhouse
15. Grow lab
16. Grow lights
17. Growing media
18. Hanging baskets
19. Heating system
20. Hoe
21. Hose shut-off
22. Hydroponics unit
23. Increment borer
24. Jiffy pots/pellets
25. Min/max thermometer
26. Mist nozzle
27. Oasis cubes
28. Perlite
29. Pesticides
30. Plant ID tags
31. Plant table
32. Post hole digger
33. Promix
34. Propagation mat
35. Propagation mat thermostat
36. Pruners
37. PVC pipe and fittings
38. Rain gauge
39. Rake, garden
40. Rake, leaf
41. Rototiller
42. Shears, grass
43. Shears, hedge
44. Shears, lopping
45. Shovels
46. Soil auger
47. Soil test kit
48. Soil thermometer
49. Spray tank
50. Swing blade
51. Timer, 24 hour
52. Timer, water
53. Tree planting bar
54. Utility cart
55. Vermiculite
56. Water breaker
57. Water hose
58. Water want
59. Watering can
60. Weed eater
61. Wheel barrow
62. Y adapter

Hand Tools

1. Bolt cutters
2. Caliper set
3. Clamp, bar
4. Clamp, block
5. Clamp, C
6. Cold chisel set
7. Dividers
8. Dowel jig
9. File set
10. Hacksaw
11. Hammer, ball peen
12. Hammer, claw
13. Hand drill
14. Hand plane
15. Level
16. Nail set
17. Paint scraper
18. Pipe cutter
19. Pipe threaders
20. Pliers, needle nose
21. Pliers, slip joint
22. Pliers, vice grip
23. Punch
24. Putty knife
25. Ruler, metal
26. Saw, compass
27. Saw, coping
28. Saw, cross-cut
29. Saw, miter
30. Saw, rip
31. Scratch awl
32. Screwdriver set
33. Socket set
34. Square, combination
35. Square, framing
36. Square, tri
37. Stapler
38. Tap and die set
39. Tape measure
40. Tin snips
41. Wood chisel set
42. Wood rasp
43. Wrench, combination set
44. Wrench, adjustable

Power Tools

1. Band saw
2. Band saw, metal
3. Drill press
4. Dust collection system
5. Furnace
6. Jointer
7. Pedestal grinder
8. Radial arm saw
9. Table saw
10. Wood lathe

Portable Power tools

1. Air compressor
2. Circular saw
3. Drill sharpener
4. Drill, cordless
5. Drill, portable electric
6. Electric engraver
7. Electric stapler
8. Hot glue gun
9. Jig saw
10. Portable grinder
11. Router
12. Sander, belt
13. Sander, disc
14. Sander, orbital
15. Shop vacuum
16. Steam cleaner

Welding

1. Arc welding unit
2. Demonstration screen
3. Leather apron
4. Leather gloves
5. MIG welding unit
6. Oxyacetylene welding unit
7. Propane torch
8. TIG welding unit
9. Welding goggles
10. Welding helmet

Aquaculture

1. Air diffusers
2. Air pump
3. Aquarium
4. Bio filter
5. Chlorine neutralizer
6. Filter material
7. Fish cage netting
8. Fish food
9. Fish net
10. Fish tank- 200 gallon+
11. Fish trap
12. Hose clamps
13. Oxygen meter
14. pH adjusting solution
15. pH meter
16. PVC pipe, valves, and fittings
17. Stress coat
18. Submersible pump
19. Thermometer
20. Timer, 24 hour
21. Vinyl tubing
22. Water conditioner
23. Water heater

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